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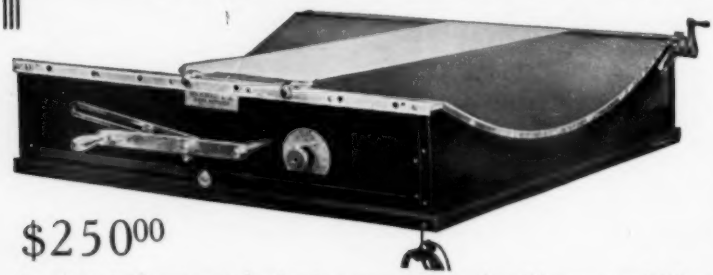

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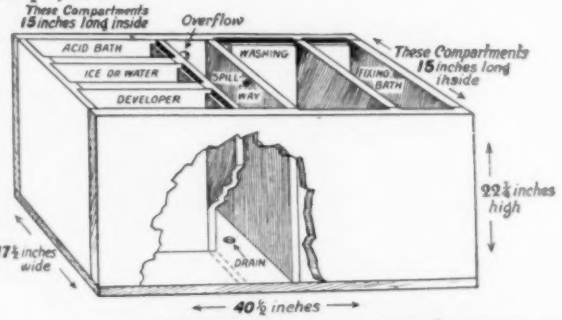

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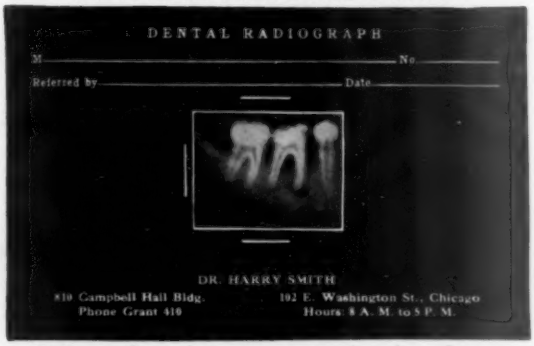

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THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

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ROENTGENOLOGICAL ASPECTS OF BRAIN TUMORS—MENINGIOMAS*

BY MERRILL C. SOSMAN, M.D., AND TRACY JACKSON PUTNAM, M.D.

From the Peter Bent Brigham Hospital

BOSTON, MASSACHUSETTS

DEFINITION AND PATHOLOGY OF THE MENINGIOMAS

THE association of certain brain tumors with changes in the overlying cranium was known to Mathew Baillie[1] and doubtless to some of the even earlier pathologists. The most common cerebral tumors causing characteristic local bony changes are the endotheliomas, or as we prefer to call them (following Cushing)[24] *meningiomas*. These tumors, formerly supposed to arise from the inner surface of the dura, are now generally believed to be derived rather from the arachnoid.[6, 20] Penfield,[26] and Cushing[24] have recently published extensive histological studies on the mechanism of production of hyperostoses by such tumors, to which the reader is referred for a full discussion of the subject. For our present purposes it is enough to notice that an inherent property of growth of the meningiomas appears to be their tendency to squeeze into small crevices and spaces of bone, at once enlarging them and irritating the bone to irregular proliferation. Some of Penfield's slides show parallel columns of tumor tissue growing in the much-distended Haversian canals of the cranium, in a direction vertical to its surface, and appearing on the outer side to form a cap of tumor tissue beneath the scalp. A corresponding structure of the bone can be recognized by the roentgen rays in some instances. These osteomatous bony changes are found most frequently with the flat, spreading meningiomas. More common are the slighter changes in the bone overlying a larger nodular meningioma, where there is no demonstrable invasion of the cranium, but only a roughening of its inner surface. The arachnoid and the tumors arising from it, appear to have some osteoplastic tendency in themselves also,[17] and microscopic evidences of calcification or even ossification are not uncommon (the so-called psammoma bodies), but calcification of the entire tumor seldom reaches a degree sufficient to cast a shadow on the film. These tumors are apt to cause great enlargement of both the adjacent arteries and veins of the brain and its coverings, rendering operation difficult and bloody.

The cerebral meningiomas represent about 12 per cent of all intracranial tumors.

HISTORICAL

The pessimism in regard to the possibility of localizing cerebral tumors (exclusive of pituitary tumors) by roentgen examination is doubtless founded on the impossibility of visualizing them directly in the great majority of cases. Souques,[28] as late as 1921, in reporting a case of "psammoma" located roentgenographically, remarks nevertheless that "radiology gives no direct information as to the location of cerebral tumors in general,"

* Read at the Twenty-fifth Annual Meeting, AMERICAN ROENTGEN RAY SOCIETY, Swampscott, Mass., Sept. 3–6, 1924.

and Krause in discussing a case presented by Gottschalk,[10] in 1907, before the German Roentgen Society, expressed a doubt as to whether a cerebral tumor ever had been shown or would be shown by roentgen rays, in which he was supported by the majority of roentgenologists present. But while some of the earlier reports are open to criticism in the light of subsequent experience, others appear convincing.[9] In 1897 Obici and Bollici[2] proposed to take a roentgenogram of a patient with symptoms of a brain tumor, but the patient died while the apparatus was being prepared. They took a plate of the intact skull, however, which showed a homogeneous shadow in the right temporoparietal region, in both lateral and posteroanterior views. A "sarcoma" adherent to the dura at the fissure of Sylvius was found at autopsy; this was probably what we would now call a meningioma, in a characteristic location. The case published by Church[3] is perhaps questionable; as the tumor proved to be a gliomatous cyst, it need not concern us here. In 1902, Pfahler[4,5] reported 2 cases, both "sarcomas" attached to the dura. The second one of these is particularly interesting in the present connection. An irregular shadow was seen to overlie the site of the tumor, and at operation the cranium in this region was found to be vascular, rough and disorganized. This is probably the first recorded instance of the recognition by the roentgen ray of the changes to be considered in the present paper. Since that time, there have been numerous case reports recording changes in the bone overlying tumors arising from the meninges,[10, 11, 12, 13, 14, 19, 21, 23, 27, 33] but the descriptions of the roentgenological findings have usually been scanty.

Schüller,[16] Naito and Schüller,[28] and Heuer and Dandy[18] have respectively made an attempt to systematize the roentgenography of intracranial tumors. Schüller calls attention to the local vascularity about tumors, and speaks of the hyperostoses and areas of atrophy which may accompany endotheliomas. He also speaks of the similarity between the shadows cast by osteosarcomas and those produced by the hyperostoses of meningeal tumors. He does not, however, give any definite criteria for differentiation of the meningiomatous hyperostoses from those he describes as caused by syphilis, chronic alcoholism, and other conditions. A fuller description of the changes in question is given in the article written with Naito, and bone formation is mentioned. We are unable to confirm his statement that benign tumors (including endotheliomas) produce sharply contoured cranial impressions, while malignant tumors produce osteoporosis. Nor have we been able to parallel the case which he reported with Schlesinger,[15] in which a deep-lying frontal glioma coincided with an osteoma of the right frontal sinus. In the experience of this clinic, gliomas appear to have no tendency to cause proliferation of neighboring bone. Some of Schüller's illustrations show the characteristic changes extremely well, however.

Heuer and Dandy,[18] in a notable paper describe and illustrate the typical cranial changes in several cases of endothelioma as disclosed by the roentgen ray. They also emphasize the importance of the vascular changes, which they imply are mainly venous, and believe that such changes may account for the bony hypertrophy. They do not distinguish very sharply between the different forms of hyperostosis which are seen, and do not recognize any characteristic changes in the region of the sella from neighboring meningiomas.

Phemister,[29] and Rand[30] have recently reported 3 cases, with excellent illustrations and descriptions, which show the characteristic changes extremely well. All three were tumors of the convexity.

The material we propose to discuss, namely, the 106 verified meningiomas in the Peter Bent Brigham Hospital series, is classified according to the point of origin of the tumor (as far as this can be determined) in the groups proposed by Cushing.[25] This classification is a provisional one, but is adopted because there are marked roentgenographic as well as clinical and pathological differences among meningiomas in various situations.*

* Twelve cases of meningiomas arising within the spinal canal have occurred in Cushing's series. None of them gave any roentgenographic evidence of their presence, and they are not included in our statistics.

1. *The Cranial-nerve-foraminal Tumors.* The most common point of origin of these tumors is the trigeminal sheath. Symptoms begin with pain suggesting trigeminal neuralgia, but followed by hypesthesia and signs of pressure. These tumors may also arise from the optic sheath (with exophthalmos) or from the eighth nerve (simulating the common neurinoma in the same situation). They are seldom operable. Out of 6 cases in this group the plates of 4 only are available for study, and in 2 of them the changes produced by the lesion could be demonstrated in the films.

2. *The Suprasellar Tumors.* Meningiomas in this situation may reach a very large size without being suspected clinically or showing definite roentgenographic evidence of their presence. Doubtless many are never recognized. The symptoms are similar to those produced by the craniopharyngeal pouch cysts in the same situation, but they arise at a later age, and rarely show any calcification, whereas the cysts usually show it.[32] Clinically, patients with such tumors show evidence of pituitary disturbance, such as adiposity, somnolence, impotence, and loss of bodily hair, evidences of pressure on the optic tracts or nerves with primary atrophy and hemianopsia, and sometimes hydrocephalus from obstruction to the foramina of Munro. They also are difficult to deal with surgically. Four cases in this group of 12 are recognizable from the plates or films.

3. *Tumors Arising from the Olfactory Groove of the Ethmoid.* This is a frequent location for the meningiomas, and they may reach a large size without being recognized. Many have been found unexpectedly in autopsies upon the insane, and many remain unverified. Usually the only localizing signs which they afford are anosmia and unilateral primary atrophy. If they grow slowly, pressure symptoms may be absent. Seven of our cases fall definitely in this group, of which only 3 were recognized roentgenographically. Newmark[14] reports a case of this type.

4. *Sphenoidal Ridge Tumors.* Such tumors may give indefinite localizing symptoms, sometimes uncinate fits and hemianopsia. Fortunately, they are often recognizable roentgenographically, 3 of the 6 cases examined showing characteristic changes in the films (Fig. 12). The plates of a seventh case were not available.

5. *Sylvian Cleft (Temporofrontal) Tumors.* In this situation the meningiomas are likely to be of the flat, spreading variety, often producing few cerebral symptoms. They may be disclosed by a subtemporal decompression. They are prone to produce an osteomatous thickening of the temporal region, and also an exophthalmos. The clinical picture is so striking that a number of cases have been reported.[8, 24] The roentgenograms of 9 in this group of 12 showed changes in the temporal bone.

6. *Tumors of the Convexities.* In a "silent" area, such tumors may grow to a considerable size without producing localizing symptoms, and the roentgen ray may then render invaluable aid in their diagnosis. In the parietal, occipital and left temporal region, they may give rise to localized paresthesia, paralyses or convulsions, or to hemianopsia or aphasia; their location then becomes obvious. There is often local tenderness to percussion or palpation. They are extremely favorable for surgical removal. This, and the next, are the largest groups, each containing 20 cases. The films of all but 3 were available for study, and the lesion could be located in 10 (Fig. 5).

7. *The Parasagittal Meningiomas.* Tumors arising from the walls of the sinuses or its lateral expansions are characteristic. What was said above concerning localization of tumors of the convexity applies to this group also; when in the motor or sensory regions they are easily recognized clinically; elsewhere they are easily missed. They are favorable for surgical removal, although usually extremely vascular. Eighteen of the 20 cases were available for study, and the tumor could be located in 12 of them (Fig. 1).

8. *The Meningiomas of the Falx.* Tumors in this situation may be extremely puzzling clinically, and usually give no roentgenological evidence of their presence, as they do not reach the cranium. A characteristic clinical picture is that of a paresis of one side of the body, with later a paresis of the opposite foot. Not infrequently,

they are associated with extremely painful convulsions. But often they produce bilateral symptoms, or give no localizing symptoms whatsoever. Their surgical removal is an extensive undertaking, but can usually be accomplished. Seven of such cases have been verified and plates were taken in 5 of these. In none of them were any characteristic changes seen.

9. *Tumors of the Transverse and Sigmoid Sinuses.* These may be supratentorial producing hemianopsia, and sometimes visual hallucinations; or subtentorial, with cerebellar signs. Their removal involves great technical difficulties. As is usual with cerebellar tumors our findings in this group were largely negative. Several showed the general signs of increased pressure, but only 4 out of the 14 in which films were taken presented localized changes. There are 15 in all in this group.

Our criteria are listed and described below, and in passing it must be noted that we have included all cases having films or plates, although many of the latter are quite unsatisfactory according to our present day standards. The cases in which no plates were taken for one reason or another, or in which the plates were lost or insufficient are listed as "unclassified." In lesions about the sella, location alone was considered, if a negative diagnosis of pituitary adenoma or suprasellar cyst could be made, as the meningiomas are the only other common tumors in this situation, but seldom produce pathognomonic changes. In all the others both the *location* and *type of lesion* had to be correctly identified, or the findings were classed as negative.

TECHNIQUE

There is no special technique in use; in fact it changes with new apparatus and new accessories. Ordinarily we use a 4½ to 5 inch gap, fine focus tube, double screens and duplitized films and a Potter-Bucky grid. Complete immobilization is of course essential, even to such a minor matter as holding the breath during exposure. Stereoscopic films are necessary to locate the finer spicules projecting internally, and they are of course most definite when the lesion is nearest the plate.

It is worth noting that in practically all branches of roentgenology, the fullest success and accuracy can be attained only when there is active cooperation and interest on the part of the clinician. This is particularly true of roentgenography of the head. According to the original reports on the cases in question, made as a matter of routine often without a summary of the clinical findings at hand, in only 37 were the changes gross enough to be recognized at once. But a second careful study with the aid of the patient's history revealed 10 more which had passed unrecognized on the first survey, although perfectly definite. It has for some time been a custom at this clinic to have a summary of the essential localizing signs and symptoms accompany the requisition for films, and roentgenologists and clinicians frequently confer in person over debatable points. Frequently a definite lesion may be missed entirely in plates taken from the wrong side of the head.

ROENTGEN FINDINGS

A description of the characteristic findings noted on the films is rather difficult, as it depends on the size and shape of the tumor as well as on its location. To locate and identify it accurately, as to type, it is necessary that some portion of it be adjacent to one of the cranial bones. For this reason the "local" changes in the cranial bones are of far more importance than the "general" changes so often unduly stressed. These latter deserve no more than a word—the convolutional impressions which indicate increased intracranial pressure were present in only 11 of our cases, which were mostly cerebellar or suprasellar tumors.

The local changes, in the order of their importance are: (1) Erosion and vascularity; (2) osteomatous changes; (3) spicule formation; (4) diffuse thickening; (5) enlargement of the meningeal channel, and (6) calcification.

By "erosion" is meant a localized, roughly circular area of thinning, which presents a mottled, spongy appearance, irregular in outline. It must be distinguished from the clean-cut, punched-out defect produced by a metastatic carcinoma

which is purely destructive. The spongy structure is no doubt due to the nature of the tumor, which invades the bone by spreading through the Haversian canals, dilating them and finally destroying the intervening bridges. This is clearly illustrated by Figures 1 and 2 which show the canals in all stages of dilatation, destruction and coalescence. A good illustration and description of such a change is also given in Phemister's article.[29]

"Vascularity" we limit to the small worm-like vascular channels which nearly always surround the area of erosion, and which frequently disappear in small, perfectly circular holes, where the vessel perforates the bone (Figs. 3 and 4). These vessels usually radiate from the eroded area and suggest the tortuous and intertwined arms of a devil-fish. Occasionally a definite arterial channel may be traced into the area of the tumor, but most of these markings are apparently due to veins, as may be seen at operation. One must recognize as normal, or at least as not associated with any known pathological process, a more or less regular stellate collection of vascular channels on the inner surface of the parietal bone, usually bilateral, and opposite the parietal bosses. This is shown in Figure 12. Attention was called to this condition by Heuer and Dandy,[18] Elsberg and Schwartz,[34] and others. When the tumor happens to be on the horizon, as it is seen on the films, the diploetic vessels are usually evident and considerably enlarged, standing out in cross-section as a series of small holes.

Associated with these two types of change there is nearly always the formation of new bone, usually as spicules or as a diffuse thickening, more rarely osteomatous in character. By "spicules" we mean slender columns of new bone perpendicular to the surface of the normal bone, frequently imitating an osteogenic sarcoma with extreme accuracy. Figure 5 is a good example of this type. "Thickening" refers to an actual increase in the size of the involved bone, which may show either an increase or a decrease in density (opacity) depending on the ratio between tumor tissue and newly formed osseous tissue (Fig. 6).

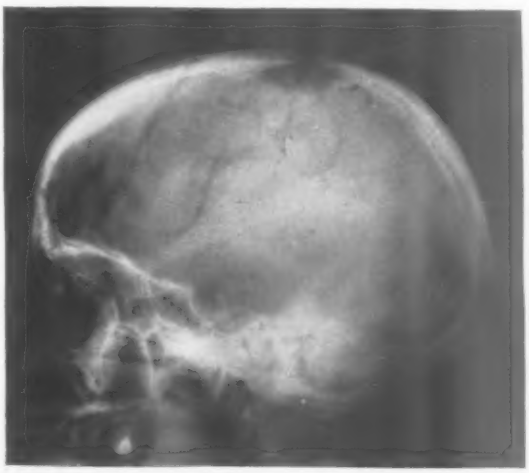

FIG. 1. Parasagittal meningioma showing marked erosion of the bone, slight thickening externally, and surrounding vascularity.

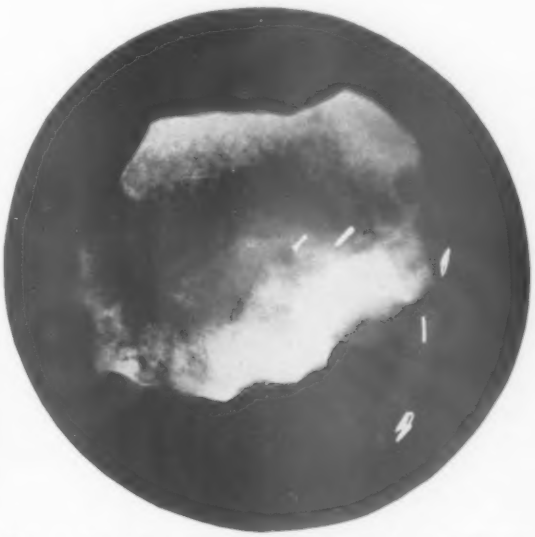

FIG. 2. Bone flap removed with meningioma adherent, showing marked dilatation and coalescence of the Haversian canals.

These three changes are the most common and are quite characteristic. When the meningioma is adjacent to one of the bones of the vault, the localized erosion and vascularity appear predominant, but when it is in apposition with the roof of the orbit, sphenoid ridge, floor of the middle fossa or petrous portion of the temporal bone, the productive (bone for-

mation) appearance dominates the picture and other changes are inconspicuous. It is unusual for one of these types of changes to occur without one or both of the other two.

FIG. 3. Extensive meningioma of the frontal bone, with the characteristic porous or spongy appearance and increased vascular channels.

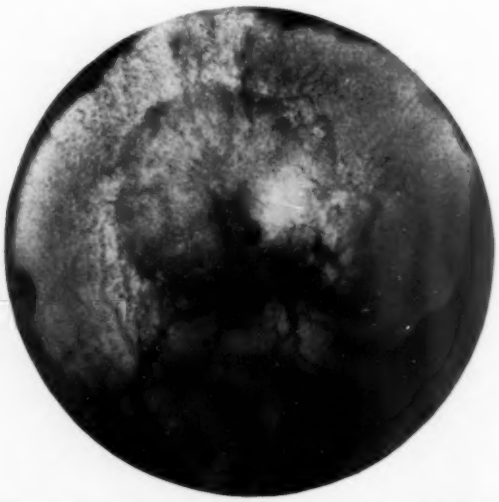

FIG. 4. Bone flap removed at operation, showing the localized erosion and the characteristic vascular channels, some of them "perforating."

The osteomatous type of change may occur independently of the other three, however. In this the bone is very dense and sharply localized and the true nature of the underlying process may be obscured. An example of such a lesion is shown in Figures 7 and 8, which is one of the two cases of multiple meningiomata in this series. Rand's case[30] is an excellent illustration of this type.

Visible calcification within the tumor is rare, occurring in only 3 cases of our series; and when present, does not accurately differentiate the lesion from the gliomas, which may also contain calcium. As a rule, calcification in gliomas is more

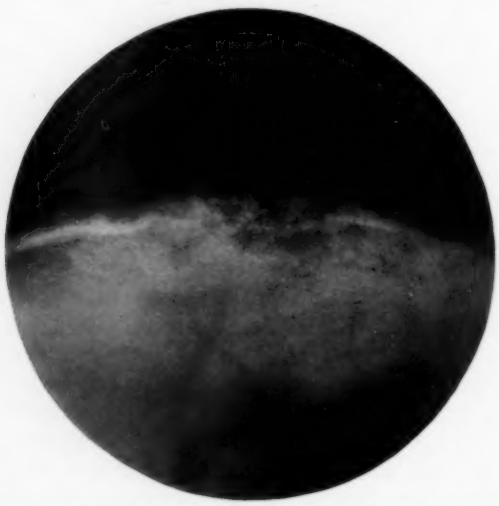

FIG. 5. Meningioma extending through the parietal bone and producing spicules externally which are perpendicular to the bone, as in osteogenic sarcoma.

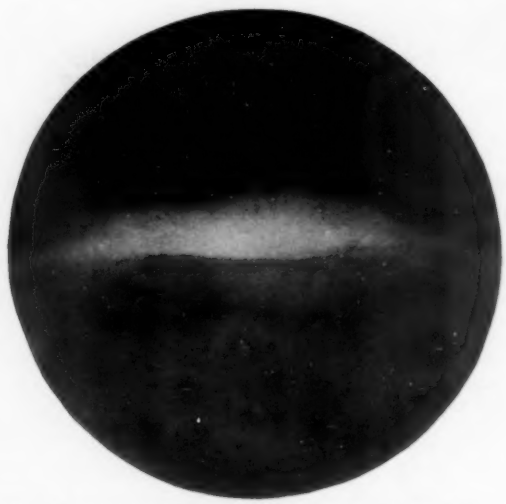

FIG. 6. Meningioma causing a flat, dense hyperostosis.

indistinct and less sharply localized, while in the meningiomas it may be very definite, and outline the whole tumor sharply. Cushing is of the opinion that these represent cases which have degenerated, healed and then calcified, so that they may have little or no importance clinically. Figure 9 shows one of these lesions in a patient whose cerebral symptoms were due to a coincident glioma of the corpus callosum, the meningioma being quite silent.* The tumors reported by Mills and Pfahler,[4] Gottschalk,[10] Algyogyi,[11] Souques,[23] and Naito and Schüller[28] probably fall into this class.

FIG. 7. Two osteomas each associated with a small meningioma. This patient died of a large cerebellar meningioma which did not show on the films.

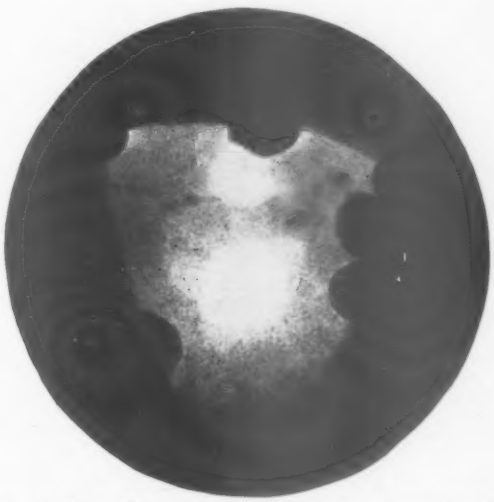

FIG. 8. Bone flap removed at operation from the skull shown in Figure 7.

In about 25 per cent of the cases the channel for the middle meningeal artery was enlarged on one or both sides depending on the location of the tumor. Liebman,[31] and also Heuer and Dandy[18] have emphasized the fact that this channel is deepened, widened and usually quite tortuous in a large percentage of these tumors, but this is also true in other tumors and occasionally similar vascularity is found without any demonstrable lesion, so that it is merely confirmatory when present, and alone is only suggestive. This is essentially the position taken by Elsberg and Schwartz.[34] Illustrations of these changes may be found in the papers referred to and in Figures 1, 4 and 5.

One other variation from normal which is noted frequently (19 cases) is sellar deformity, which is most common, as suggested above, in the pituitary or suprasellar meningiomas. Aside from those it has been noted in (a) large tumors anywhere causing pressure absorption, and (b) tumors of the sphenoid ridge or floor of the middle fossa with direct encroachment of the sella. These latter may be recognized by the *dense*, mottled or spongy bone replacing or obscuring the outlines of the sella, usually with characteristic spicules. The conditions causing such changes have been considered by Schüller[16] and by Wexberg.[22] The distortion of the sella may be such as to give rise to an erroneous diagnosis of adenoma of the pituitary, which occurred 8 times in our series, mostly among the earlier cases.

DIFFERENTIAL DIAGNOSIS

A differential diagnosis of the meningiomas from syphilis may be difficult, but the latter is more apt to produce a simple worm-eaten area or areas (frequently several small ones which may later coalesce) without the vascular channels or stalactites so common in these tumors. Syphilis responds so quickly and these

* It is interesting to note that this patient also had a carcinoma of the prostate and an adenoma of the kidney.

tumors grow so slowly that the therapeutic test may be employed in cases with a positive Wassermann reaction. Metastatic carcinoma is not apt to be mistaken because of its relatively greater destruction. Osteomas may occur alone—the true pedicled cauliflower type as in Figure 10, and may so resemble the meningiomas that the diagnosis is made only by operation. One case in this series was operated upon under the diagnosis of osteoma, and the meningioma was only found at a

FIG. 9. Calcified meningioma in the occipital lobe, probably quiescent (see text).

FIG. 10. True pedicled osteoma arising from the floor of the middle fossa not associated with a meningioma but producing similar symptoms.

FIG. 11. Osteogenic sarcoma arising in a diffuse benign hyperostosis not associated with meningioma.

FIG. 12. Meningioma of the sphenoid ridge without encroachment on the sella. "Stellate veins" are seen in the parietal region (see text).

second operation. Such mistakes must have happened frequently in the past, as probably, for example, in a case reported by von Eiselsberg.[8] Naito and Schüller[28] call attention to this danger. Osteogenic sarcoma may resemble a meningioma even more closely from a roentgenographic point of view, but the two tumors differ usually in rate of growth. Figure 11 is an example of an osteogenic sarcoma, but the changes usually ascribed to such a lesion appear much more prominent in Figure 5, previously noted, where the perpendicular periosteal spicules of new bone are due to the invading meningioma.

VENTRICULOGRAMS

Ventriculography was employed in only 4 of the cases in the present series, and led to a correct diagnosis in 2 of them. In one, a re-examination of the original stereos showed changes which in the light of subsequent experience could be recognized as due to the presence of a meningioma.

TREATMENT

These tumors are only locally malignant. They may invade bone, muscle and adjacent organs or tissue, but do not metastasize. Ordinarily the symptoms are caused entirely by pressure and displacement. They do recur locally, as several (5) of our cases have been operated on, one as long as nine years after the original tumor was removed. These recurrences often present the same localized changes of erosion, vascularity and hyperostosis and, if so, may be recognized, usually at the margin of the bone flap. Occasionally displacement of the silver clips placed on the dura or vessels at the first operation gives an indication of the presence of a recurrence. In view of their low degree of malignancy and their enucleability, surgical removal may be highly successful. The technical difficulties, especially in certain locations, are often extreme and occasionally insurmountable. In a few of these, as well as a few in which the diagnosis was at first uncertain, radiation has been tried but with no encouraging results whatsoever.

SUMMARY

(1) The roentgenological findings in a group of 95 verified intracranial meningiomas have been reviewed. Of these, 47 or 49.3 per cent showed recognizable changes characteristic of the tumor. In the films of 11 cases of meningioma of the spinal canal, no definite changes could be seen.

(2) The bony changes which are considered characteristic are: (1) Erosion and vascularity; (2) osteoma formation; (3) spicule formation; (4) diffuse thickening, and (5) enlargement of the meningeal channels. A sixth manifestation is the calcification of the tumor itself, which is probably a regressive change.

(3) These changes are most frequently and clearly seen in meningiomas of the vault. Tumors about the sella are apt to cause a nonspecific distortion and destruction of the clinoids. Tumors of the base are often accompanied by a diffuse thickening of the floor of the skull. Those arising from the falx, from about the sella, or from the sinuses of the posterior fossa are least likely to give any indication of their presence.

(4) A brief review of their comparative incidence, pathology, and classification is also given.

We are indebted to Dr. Cushing for the privilege of studying this series of cases from his clinic, and we express our appreciation for his suggestions and criticisms.

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DISCUSSION OF PAPERS OF DRS. BAILEY, AND SOSMAN AND PUTNAM

Dr. Harvey Cushing, Boston. It is a great privilege to come here before this society. I appreciate it the more because I began my medical life as a voluntary roentgenologist. I may be permitted for a moment to reminisce about the matter. It was, I think, in the spring of 1896 when I was a house officer at the Massachusetts General Hospital that Dr. J. C. Warren, then professor of surgery in the Harvard Medical School, came back from Roentgen's laboratory and showed us a shadow picture of the human hand in which the outlines of the bones were apparent. He showed us, too, a mysterious glass tube about as big as an orange with which the picture had been taken. It of course aroused the greatest possible interest. E. A. Codman and I with the help of Walter Dodd, the hospital pharmacist, who knew something about photography, immediately began to see what we could do in the way of getting similar pictures. This, I suppose, is nothing more than what happened in many other parts of the country at about this time.

It was in that fall of 1896 that I went to Johns Hopkins and made the first roentgenograms that were taken there, with the aid of a decrepit and perverse static machine as big as a hurdy-gurdy and operated in the same way, by turning a crank. My first paper submitted for publication contained an account of a case of gunshot wound of the spine with plates showing a bullet which a Baltimorean had planted in the body of his wife's sixth cervical vertebra. I once showed these pictures to Dr. Cole and he expressed himself as astonished that such good plates of a spine could have been taken in 1896; but I do not know whether I told him, as I shall now confide to you, that the plates were the result of exposures averaging 35 minutes. And I may add that the pictures which were reproduced were not those of a single experience, for I think the patient was given as many as half a dozen sessions at least, before plates were secured which were sufficiently good for reproduction. Needless to say, she was a most cooperative patient.

Subsequently a Willyoung coil was purchased which I think had a spark gap of 2 or 3 inches. With this coil and the aid of many bottles of rodinol (I do not know whether

rodinol is anything more than a memory for the few grey heads in this audience), I spent many weary hours for the next year or two in an improvised dark room off from the old amphitheatre at the Johns Hopkins Hospital developing roentgen-ray plates in which no one at the time took any very great interest. Certainly none of us could have had any possible conception of the increasingly important rôle the roentgen-ray was to play in clinical diagnosis and treatment.

One thing in particular has come to my mind as I have listened to the report of my friend Dr. Sosman. It is this: A sound knowledge of pathology is no less necessary for the roentgenologist than for an expert in any other department of medicine. It is possible for you to detect with accuracy many deviations from the normal which for others, without your aid, would remain largely a matter of guess work. A roentgenologist, in short, thoroughly versed in pathology becomes a specialist of a high order; without this knowledge, he remains merely a technician, however expert a one he may be.

I fail to see how plates such as Dr. Sosman has shown can be properly interpreted unless one has a clear idea of the lesion itself which has provoked these changes in the bone; and it is an interesting fact that a surgeon nowadays is perhaps more likely to find the roentgenologist peering over his shoulder at the operating table than one of his medical colleagues.

I doubt whether there is any field in which roentgen-ray interpretation is more difficult or in which experience and a knowledge of pathology is of greater value than in that of brain tumors. And there are probably few disorders in which roentgen rays may be of greater diagnostic aid.

When we compare such pictures as those we have just seen with the unsatisfactory plates with which we had to be satisfied only a few years ago, we may be well content with our progress in technique. Even so, I do not suppose we can any of us foretell what may still be in store—possibly even the actual identification and outline of a tumor because of its difference in density from other parts of the brain. This must be our goal.

In the meantime, we have to rely, for the detection of intracranial tumors, on secondary signs: (1) on the deformations such as occur in the region of the pituitary fossa, or perhaps also on the dilatation of the internal auditory meatus in acoustic tumors, or on the enlargement of the optic foramen in tumors of the chiasm; (2) on the presence of lime salts within tumors which cast shadows as in the cranial pharyngeal pouch cysts or in certain types of glioma or spongioblastoma; (3) on such a procedure as ventriculography which is of undoubted aid in a small percentage of cases; or (4) on the changes produced in the bone adjacent to a tumor.

In his chosen topic, Dr. Sosman has restricted himself to a consideration of the bony changes produced by the meningiomas as we call them; but unless one has a clear idea of the lesion itself which has provoked these changes, I do not see how the plates can be properly interpreted.*

Dr. G. E. Pfahler, Philadelphia. I have always been very much interested in this subject. My interest first was aroused by association with Dr. Charles K. Mills in the Philadelphia Hospital in 1900, at which time we demonstrated and localized the first of these tumors. The localization of the tumor had been made clinically and the roentgen examinations were merely made to find out whether we could really demonstrate anything, which at that time was extremely doubtful.

I would like to ask the speakers whether cerebral pneumo-roentgenography has been of any assistance, and whether they can tell us how to differentiate the cysts involving the pituitary region and the adenomas, because after all that differentiation must be made or we cannot choose which of these we will treat.

Dr. C. A. Waters, Baltimore, Md. I am glad to have the opportunity to state that our results in the treatment of brain tumors with roentgen rays have been almost identical with the results of Dr. Bailey. I have in mind 2 cases which Dr. Dandy turned over to me for treatment, both gliomas; one was in a middle-aged man. The glioma had been removed but it seemed probable that there would be a recurrence. This patient was treated three times over a period of a year, with the result that he is entirely free of symptoms now, and one hemisphere of his brain has completely atrophied. At the same time, the other case went on to death. So that it is impossible to tell whether the first case may not have been one of the types of glioma which would have remained well without roentgen treatment.

Dr. Sosman, closing. Dr. Cushing has refrained from mentioning the end results in these meningiomas. I would like to emphasize strongly the fact that they are very favorable for surgical removal and that his end results are really remarkable. I do not believe there is anything more satisfactory in the whole realm of cranial surgery than the exact localization and identification of one of these tumors and its successful removal.

* Dr. Cushing proceeded to show a series of lantern slides of meningioma in the different parts of the intracranial cha 1 r: where they are most likely to be found.

In the treatment of brain tumors by the roentgen ray, it is quite necessary to have thorough cooperation. Dr. Bailey sees each of our cases every time the patient comes in; and especially in the pituitary cases does visual fields to determine whether they are being contracted or expanded by the treatment.

In answer to Dr. Pfahler's question regarding cysts and adenomas, the suprasellar cysts are quite characteristic in 75 per cent of the cases. They show typical, what you might call flocculent calcification directly above the sella, occasionally inside the pituitary fossa. They do not always show the pituitary deformity, although the majority of them do. If you do not see that calcification, you presume that it is an adenoma, unless you have the marked destruction of an adenocarcinoma, or unless you have the pressure deformity from the suprasellar meningioma.

Finally, ventriculography has helped us very little in this series of cases. As I remember, we used it in only 3 or 4 of the 125 cases, in 1 of which it very badly misled us. In the other 2 cases it helped us decidedly.

THE CLINICAL IMPORTANCE OF CHRONIC CHANGES IN THE APPENDIX*

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SINCE most patients are sent to our private clinic both for diagnosis and for treatment, we have an opportunity not only to examine the patient and note the anatomical and functional changes present in the appendix, but also to follow up the patient for years afterward and see what becomes of his symptoms and of his appendix; and we thus have an opportunity to find how important these chronic changes are to the patient himself.

We have carried out these observations for the last seven or eight years, and have come to some definite conclusions.

The term "chronic appendix" is a poor one. There are practically no chronic inflammations in the appendix with the rare exception of tuberculosis. There are many chronic changes resulting from previous or recurrent inflammation, such as scar tissue, fibrosis, adhesions, and obliterative changes.

The direct roentgen signs of chronic changes in the appendix are tenderness, fixation, kinking, changes in shape and position, lack of filling, slow emptying, beading and adhesions.

The indirect signs are pyloric spasm, gastric residues and ileal stasis. Most of the signs are suggestive rather than definite, and several, the more the better, are needed for a diagnosis. Up to a few years ago there was much difference of opinion about the value of some signs, such as the filling and emptying of the appendix, ileal stasis, etc.

These signs are numerous and graphic, and because they are so easily seen are apt to be over-emphasized. The roentgenologist has a heavy responsibility when he makes the diagnosis of "chronic appendix," for this is frequently equivalent to saying to the family doctor or surgeon, "take it out."

Clinical experience has shown that we should be slow in diagnosing chronic appendicitis as a cause of digestive symptoms unless there is a clear history of previous acute or recurrent attacks, and no other cause is found. This diagnosis is much too frequently made. Fully one-half of the patients whose appendix is taken out for chronic indigestion (not acute attacks) return with the statement that they have found no relief from operation. A careful history would have saved many of these patients a needless operation. Many have an ulcer or gall-bladder disease; more still have a purely functional, not organic indigestion.

We will discuss the roentgen signs briefly, and then discuss their clinical importance, and note which signs are most frequent in the operated group of cases, and which are most frequent in the non-operated group. We will also show some illustrations of appendices with chronic changes, which have been taken

* Read at the Twenty-fifth Annual Meeting, AMERICAN ROENTGEN RAY SOCIETY, Swampscott, Mass., Sept. 3–6, 1924.

out, and others which have been left in the abdomen for two to six years after the roentgen examination.

We shall say nothing about the technique of the examinations, except to emphasize the use of the horizontal position and of screen palpation as well as plates, as suggested by Case long ago. The horizontal roentgenoscope is very valuable in order to get down into the right lower quadrant to palpate the appendix to see if it is tender, and to get a good view of it by pushing the cecum and

FIG. 1. Normal appendix, wavy type.

ileum out of the way, and also to detect adhesions. The examination of the appendix is usually part of a complete gastrointestinal examination, and the appendix may be filled at the end of six hours, but at this time it is often covered by coils of ileum, and not easily seen. The best time for examination is from twelve hours onward after the ileum is empty. It may be necessary to follow the patient for two days or more, to see if there is delay in emptying the appendix.

DIRECT SIGNS

Tenderness is the best single sign of pathology. The patient rarely needs operation if there is no tenderness when the appendix is moved under the palpating finger or spoon. This definite tenderness of a visible appendix is a far more valuable sign than tenderness over McBurney's point, which may be over the appendix, or may be five or six inches away from it. It is possible to have no tenderness between attacks in recurrent appendicitis, but the patient usually comes for examination when some symptoms are present, and tenderness is our most constant sign in the cases requiring operation.

We must be very cautious in ptosis cases. The heavy, full, atonic cecum is often tender. In this group most mistaken

FIG. 2. Appendix shows typical "beading," some fixation; not tender. No operation, no symptoms for 2½ years after roentgen examination.

diagnoses are made, and most needless operations are found. If we find a tender, low cecum, and no appendix visible, we must not hastily conclude that we have a tender, retrocecal appendix.

Filling. Extreme views have been held within a few years. On the one hand, George[1] says that every normal appendix fills, and if it does not, it has an obliterated lumen and is pathological. On the other hand, Skinner[2] states that every normal adult appendix does not fill, that the appendix is the "abdominal tonsil," a lymphoid structure, and that adult appendices should obliterate, and not fill, and if they fill they are pathological.

There is no need to be misled here. Practically all pathologists agree that obliteration is a sign of disease, and is due to repeated deposits of scar tissue (Figs. 13 and 14).

There is considerable evidence that the appendix may fill and empty more than once during the usual examination, and it is not safe to diagnose an obliterated appendix simply because it is not seen. In our experience, the appendix has been found filled at some time during the examination in a little more than half the cases, and when it is not seen little can be said about it.

FIG. 3. Appendix shows some fixation, angulation and beading, not tender. No operation, no symptoms for 6 years after roentgen examination.

FIG. 4. Appendix in front of partly filled cecum, to which it is adherent, the upper end is hook shaped, and cannot be straightened out; not tender. No operation, no symptoms for 1½ years after roentgen examination.

I do not believe that the kind of barium meal used, whether buttermilk or starch gruel, has much influence on the filling of the appendix. There is no real difference in the percentage of appendices seen with the two kinds of meals. George,[1] with a buttermilk meal gets 70 per cent filling, and Ström,[3] with potato gruel reports over 70 per cent filling; and the different figures reported by other authors, namely 50 to 70 per cent, probably represent partly the degree of intensive study and care in the examination.

Segmentation or Beading. This has been commonly called a sign of disease in the past. It is well illustrated in Figures 2, 3 and 5. It is interesting to note that it is never found at autopsy or operation. What is it due to? Possibly to tonic constriction rings, such as are seen in the colon of the dog and rabbit; possibly to drying out and separation of the contents of the appendix; possibly to contraction of the mucous membrane, as has been so beautifully shown by Forssell elsewhere in the digestive tract. It is too constant for peristalsis, and is shown on films repeated at intervals in the same case. It is found in about one-third of the normal cases, and has no value as a sign of pathology.

Filling around fecal masses which show in the appendix like "peas in a pod" is quite frequent, and may be found in almost any individual. It is most marked in appendices which do not empty well (Fig. 5).

Emptying. The normal appendix empties usually in a day or two, occasion-

FIG. 5. Appendix shows barium filling around fecal masses "like peas in a pod," tip somewhat fixed, not tender. No operation, no symptoms for 4 years after roentgen examination.

FIG. 6. Beaded, bulbous, tender appendix, remains filled after cecum has largely emptied. Appendectomy.

FIG. 7. Appendix points upward behind cecum with tip above crest of ileum, tender. Appendectomy.

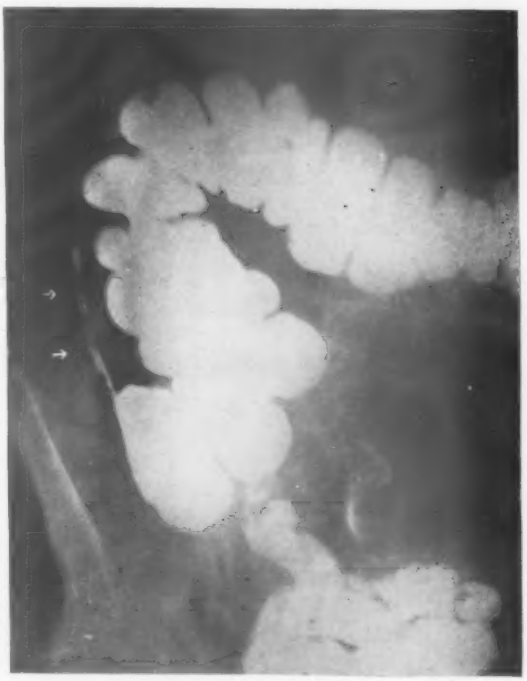

FIG. 8. Appendix points upward, outside cecum, not tender. Age of patient sixty-four. No operation, no symptoms for one year after roentgen examination.

ally not for three or four days, but we are suspicious of poorly draining appendices, which remain filled for a day or two after the cecum is empty, especially if any other signs are present, such as tenderness, narrowing or fixation (Figs. 6 and 10).

We have seen a few surprising cases (Figs. 11 and 12) where the signs have been much more striking than the symptoms, and where the appendix although kinked and not empty at the end of three to five days was not tender, and seemed to be making no trouble, and has remained without symptoms in the abdomen for years after the examination.

FIG. 9. Appendix curled up, beaded, moderately tender. Operation advised. Mild intermittent symptoms after roentgen examination. Appendectomy 2 years later.

Fixation is important, but is so well known that we shall pass over it briefly. It is especially significant if one part, such as the tip or median part, is fixed with kinking and deformity. There is considerable normal variation in the mobility of the appendix, its mesentery like that of the cecum is variable, so that some are very free and others quite fixed, also the thickness or the rigidity of the patient's abdomen or a low position of the appendix in the pelvis may make it hard to palpate. Appendix adhesions may deform the ileum, cecum or transverse colon.

Changes in shape, such as kinking, angulation, narrowing, irregular dilatation must be constant to be diagnostic. There is much normal variation in the shape of the appendix at different times according to the degree of filling.

The position of the appendix in the right lower quadrant is fairly constant, but is partly accidental. It may be high or low depending on body form, and the position of the cecum. It is quite variable in the same case at different times, and in the upright or horizontal positions. The appendix is very frequently far from

FIG. 10. Fixed, irregular, tender appendix, narrowed at base, remains filled after cecum is emptied. Appendectomy.

McBurney's point, even five or six inches or more; every radiologist knows this, and every clinician should. It may be very obviously out of place, such as bending upwards, or behind, or outside the cecum (Figs. 4 and 7). We are rightly suspicious of such appendices, especially if tender, but position is not everything, and we occasionally find them in unusual positions outside the cecum or behind it without any clear proof of pathology (Fig. 8).

INDIRECT SIGNS

Ileal stasis has some value in diagnosis. It may be due to partial obstruction from

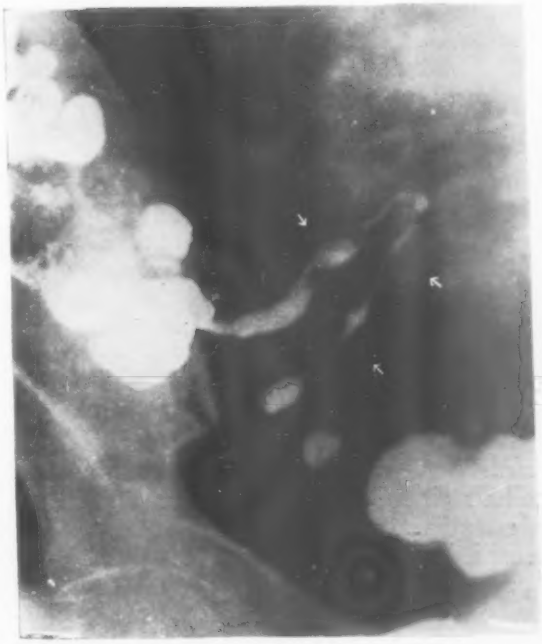

FIG. 11. Long, angulated, beaded appendix, tip somewhat fixed, very little tenderness. See Figure 12.

FIG. 12. Same case as Figure 11, distal half of appendix well filled after 5 days, somewhat fixed, very little tenderness. Operation considered desirable. No operation done. No local symptoms for 2 years after roentgen examination. Patient has diverticulitis of descending colon.

FIG. 13. Typical obliterative changes. Appendix very short and narrow, mobile, not tender. No operation. No symptoms for 1½ years after roentgen examination.

FIG. 14. Typical obliterative changes. Appendix very narrow, mobile, not tender. No operation. No symptoms for 3 years after roentgen examination.

adhesions starting from the appendix, but it is important to remember that there are other causes. Let me illustrate with a case report. The roentgen examination after a barium meal reads: "Considerable delay in the ileum, no barium reached the colon in 6 hours, barium residue in the ileum at the end of 12 hours; diagnosis, probable adhesions in the ileocecal region, question of chronic appendicitis."

We find that the patient is an old lady, aged seventy, who does not empty the ileum well, neither would she run a block very well. Emptying the ileum is a muscular effort. The delay here is atonic, the result of weak muscles; it is not obstructive, and there is no question of appendicitis.

The moral is, don't stress ileal stasis in weak, sick, old people, or in atonic, ptotic cases. Here most mistakes are made, and most appendices taken out needlessly. The picture is ileal stasis, low, full, tender, slow-emptying cecum, sensitive nerves, pain or distress in the right iliac region; the diagnosis of chronic appendicitis is made; the appendix is taken out, and the patient is no better.

The gastric signs are pyloric and duodenal spasm. They have little value in the diagnosis of chronic changes in the appendix. Pyloric spasm is often found, but there are so many other causes, both in and outside the stomach, such as, hyperacidity, ulcer, disease of the gall-bladder, tobacco, or neurasthenia, that it has little diagnostic value.

With regard to gastric residue in 100 cases published by the author[4] six years ago, with chronic changes in the appendix, one-half of which had adhesions in the ileocecal region, and almost one-half with ileal stasis at the end of twelve hours, *in only* 7 was there delay in emptying the stomach. In short, delay in emptying the stomach is the exception, not the rule, and is not a good diagnostic sign of chronic changes in the appendix. It is only met with about once in 15 cases.

Alvarez has compared the intestine to a railroad with a block system, where delay down the line holds up the bowel contents for several blocks above. This is not always true and depends on the character and degree of irritation low down in the bowel. Our clinical and experimental work on animals and men all pointed definitely one way, showing that *delay in emptying the stomach is the exception, not the rule in lesions of the lower bowel*, and that *a strong stimulus is needed from the lower bowel to slow the stomach.*

Incompetent Ileocecal Sphincter. This has little relation to the appendix. It is too common in the absence of chronic changes in the appendix to have any diagnostic value.

CLINICAL IMPORTANCE OF THE SIGNS

Are there any normal appendices in adults? We often read that "pathologists tell us there are no normal appendices." Mallory, the pathologist at the Boston City Hospital, says that probably all the appendices taken out at operation for acute and chronic appendicitis are pathological. Is this simply the kind-hearted pathologist backing up the surgeon, or is appendicitis so common that nearly all adult appendices are pathological, and we are almost always sure to find a diseased one?

How many normal appendices are found at autopsy? Mallory, in 4,000 routine autopsies at the Boston City Hospital found the appendix *normal in gross* in 95 per cent. There were no adhesions, no kinking, no scar tissue, no obliterative changes, no constriction, no deformity of shape; not one of the signs so easily found by roentgen examination. In 3 per cent of the autopsies there were adhesions, scars, or obliteration of the appendix; in 2 per cent, there was inflammation, gangrene or perforation. There were three concretions in 4,000 cases. In short, when we get roentgen evidence of gross, chronic changes in the appendix, they are not universal. They have importance. They are found in only about 5 per cent of adults.

The roentgen examination of the appendix is a very delicate method. It discovers many things which were unsuspected, and incidentally many things which may trouble the patient very little, such as, poor mobility, small fecal masses, peculiar shapes, obliteration of the lumen, beading and moderate delay in emptying. These

are common signs in our non-operated group, and we have seen these patients going about for two to six years after the roentgen examination with practically no digestive symptoms. When such signs therefore, are discovered, we must not make too much of them, either consciously or unconsciously. Graphic roentgen evidence is striking, and makes a great impression, and when it is given to the family doctor or surgeon, it does no harm to remind him of these things. No organ is so often removed without cause, because of some anatomical change.

In our operated group, we always found different roentgen-ray signs. The most important were tenderness of the appendix, constant changes in shape, fixation and abnormal position. The less important were abnormal filling and emptying of the appendix and ileal residues; beading is considered normal.

Finally, the diagnosis should be made only in connection with the clinical history. We have usually found that if the appendix, is taken out on account of chronic changes without a history of acute or recurrent attacks, the patient is not benefited.

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DISCUSSION

Dr. A. Howard Pirie, Montreal. Dr. White has given us a very conservative resumé of the present status in regard to diagnosis of appendix disease. It seems to me that the diagnosis of appendicitis or chronic appendix by roentgen rays, as is the case with all our diagnoses, ought to be confirmatory of the clinical diagnosis. In our roentgen examination, there is no one special series of signs by which we can be absolutely certain that we are dealing with a chronic appendix.

Dr. White has enforced, I think, the only thing which we should trust to, that of seeing the appendix full, putting a finger over it, feeling it and seeing that it is tender. If the patient says this manipulation is not painful, I think that fact is the most important one on which to exclude a chronic appendix.

Dr. White showed us an appendix hanging down into the pelvis; he said he could not understand why it did not trouble the boy. I have seen many appendices which hang down into the pelvis; those that do, take a very long time to empty. That is probably accounted for by the fact that since the barium is very heavy, the appendix hangs downward and there is very little peristalsis in the appendix; whereas if the appendix had an upward direction, the barium would not tend to lie so long.

Dr. L. T. LeWald, New York City. I wonder if Dr. White would care to venture any opinion as to a time limit for a normal appendix to empty, whether it would be four days or a week. If there is retention over a week, I regard it as exceedingly suspicious, and in 1 or 2 cases where there was not definite tenderness but only this extreme retention, I have ventured to recommend operation, and have not been disappointed; so that I would not think that the sole criterion in the diagnosis of chronic appendicitis would be tenderness.

One other point has appealed to me: Dr. White said that in only a few cases was there a reflex spasm about the pylorus. In 2 cases, the question of diagnosis of duodenal ulcer was brought about by this spasm, and in 1 case a definite diagnosis of ulcer had been made, and the operation was not performed; the patient wished to avoid a large scar from exploration, so on finding long retention in the appendix—four weeks in this case—the sole operation was removal of the appendix, and the patient after a year had been entirely relieved of his symptoms, so that we presumed that the removal of the appendix in that case relieved the spasm at the pylorus.

I think Dr. White's contribution is exceedingly valuable and his series will help us in estimating the value of this sign.

Dr. J. L. Kantor, New York City. I think this contribution of Dr. White's is one of the most level-headed I have ever heard. Its chief value to us, as clinicians, seems to me to be in the fact that he does not focus too much attention on the responsible rôle of the appendix in the symptom-complex of the patients who came to him for treatment. I think we are now in a position where we can go one step farther and make a helpful suggestion as to what to do for these cases.

It is obviously not to take an appendix out right away in all cases. That Dr. White has shown beyond any question. The thing to do

in our present knowledge, it seems to me, is to shift our attention from the right side of the abdomen a little more to the left side of the abdomen; to shift it from the appendix, as a minute thing, to the colon as a large thing, and to pay attention more seriously to colon function and to the restoration of colon malfunction. It seems to me if we do that, we will do a little more to relieve the patients.

At the Vanderbilt Clinic we believe that every case of constipation will show a filled appendix. If we get a series of films in which the colon does not empty at 46, 72, or 96 hours, or thereabouts, we expect to get that appendix visualized, or if it isn't there, we ask when it was removed. We owe much of the credit for this idea to Dr. Mills.

There is always a legitimate doubt in our minds as to how far we can let a patient go with an appendix, because of the acute misfortunes in case of infections. Dr. John Bryant showed that in sthenic persons the appendix acts more like a culture tube in those individuals, is more likely to infection and acute damage, and in asthenic persons the appendix empties more freely and is less subject to infection. If we find a suspicious case in a sthenic individual we are more anxious to have him under careful observation, and the question of surgery is always in our minds as an open proposition.

Dr. A. L. Gray, Richmond, Va. I think one reason we don't get more positive filling in appendices in adults is due to the fact that we don't examine them frequently enough after the administration of the barium meal. Most of us have a certain routine and either examine 6 hours afterward or 24 hours afterward or 8 hours afterward. I think very often the appendix will fill in the interval between our examinations and empty before we examine it again.

Personally, I attach very little importance to segmentation in the appendix. I am inclined to attribute it to peristalsis, perhaps from shrinking of the column of barium, as Dr. White has suggested; and also I attach very little importance to the degree of tenderness. If tenderness is present, it means not only that there is some pathological condition of the appendix, but also that there is either an acute condition or else a subacute condition. This is especially true in the case of children. The late Dr. Maguire Newton, a pediatrist of our city, conceived the idea that so-called acidosis might in some way be associated with pathological appendices. He recalled the fact that in his very extensive pediatric experience he had rarely, if ever, heard of a chronic appendix, but had to deal only with acute appendices. With this idea in view, he decided, in conjunction with myself, to make some investigations, and we examined cases of acidosis in children from 2 to 3 years up to 8 or 10. In quite a number of these cases was I able to demonstrate adhesions, prolonged retention in the appendix, the presence of concretions in the appendix, and in not one single instance could I make out definite tenderness in one that was suffering from acidosis. In all of these cases in which the appendix was indicted, operation was performed, and a definite cure of the acidosis resulted.

I intend to prevent a paper to this Society when my number is sufficient to be definitely conclusive, but I have only some 20 or 25 cases of this kind at present. I am satisfied that the fixation, the presence of concretions, and the delayed retention will account for gastrointestinal manifestations, even though there is no tenderness whatever on palpation of the appendix.

Dr. A. S. Merrill, Manchester, N. H. Dr. White has mentioned, the fact that a deformity of the appendix very often has some pathological significance of a remote nature, but not any immediate clinical significance to the patient necessitating operative interference. That is of great importance. The evidences of gastric irritability, perhaps duodenal irritability are present in a certain number of cases and slight gastric delay is also present in a certain number of cases, but perhaps not more so than in a certain number of cases of abdominal irritation starting from other sources. I find in a large number of cases about the same percentage of gastric delay in these conditions as you find in atonic conditions without the appendix.

I think the point of tenderness, as brought out by Dr. White, is of great significance. The point that the tenderness accompanies the movement of the appendix, when the appendix is movable, is also very strikingly significant. But in speaking of tenderness in this region, we must not forget that the appendix, cecum and large bowel are not the only organs which especially in the ptotic cases, are found in the pelvic region.

If the patient is a woman, I always take this fact into account in considering the point of pelvic tenderness. A gynecologist should probably be called into consultation in these cases.

Dr. White, closing. Dr. LeWald asked about the normal time of emptying the appendix. I don't know that I have any right to specify a time. My belief is that it may be two or three days, and if it takes longer than that we watch the case with a good deal of care.

With regard to pyloric spasm, we found (as you saw) a rather small group, not more than 7 per cent, in which the pyloric spasm was sufficiently important to cause retention of the stomach contents; but I think we often get spasms. However, there are so many other causes, such as the gall-bladder and ulcers of the stomach and hyperacidity, and so on, that it is not a valuable diagnostic sign.

I am sure we would find more appendices filled, if we examined the appendix more often during our routine.

With regard to tenderness, although it is a subjective sign and we have to depend upon the patient, I still feel that it is a very valuable point, and if we get a tender appendix, I think it is a point which favors operation; and if we find an appendix not tender when we roll it under our finger, I feel more inclined to delay operation, even if the other signs are present.

THE EFFECT OF BRONCHOSTENOSIS UPON THE ROENTGEN-RAY SHADOWS IN CARCINOMA OF THE BRONCHUS*

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THE problem of the diagnosis of primary neoplasm of the lung seems at the present time to be attracting considerable attention, if one may judge by the frequency with which the subject is discussed at medical meetings. Indeed, this problem, which is occasionally relatively easy as clinical problems go, is often very difficult to solve, and unfortunately seems to be presenting itself more and more often for solution.

Ewing[1] states that primary carcinoma of the lung may arise from three different types of cells: (1) from the bronchial epithelium, (2) from the mucous glands, and (3) from the alveolar epithelium.

It is not possible to discuss satisfactorily at this time the diagnosis of primary carcinoma of the lung and to illustrate with cases showing the numerous different manifestations of this disease. Consequently the present discussion will be limited to one rather narrow phase of the question. Its object is merely to point out the remarkable changes in the shadows on the roentgenogram which may take place as the disease progresses and to indicate the rôle which bronchostenosis plays in the production of these changes.

It seems advisable first briefly to trace the events which accompany the development of bronchial carcinoma. As the tumor grows it does two things locally; (1) it invades the surrounding tissues, and (2) it gradually fills up the lumen of the bronchus causing more and more obstruction and in some cases finally obliterating it completely. Occasionally the disease is terminated by hemorrhage or some other accident before bronchostenosis occurs, but this in our experience has been uncommon.

An interesting discussion of the effects of closure of a bronchus is given by MacCallum.[2] When complete occlusion occurs, as Manges[3] has shown in his foreign body cases, there is collapse (atelectasis) of the corresponding part of the lung because the air remaining in the alveoli is quickly absorbed by the circulating blood. When the obstruction is incomplete, the bronchi distal to it become dilated. Hence in the gradually developing stenosis of a bronchial carcinoma the condition is first that of incomplete obstruction, and bronchiectasis follows with infection in its train. As the occlusion becomes more marked, atelectasis with its ensuing fibrous changes complicates the picture, although apparently it does not take place as suddenly as it does in a normal lobe, the bronchus to which is suddenly occluded as by a foreign body. As a result of the atelectasis or of the infection or of both, there is a marked thickening of the pleura. This is sometimes accompanied or followed by

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an effusion which may be limited by the pleural adhesions.

With the development of bronchostenosis definite changes may take place in the clinical picture as well as on the roentgenogram. The patient's condition becomes worse and he develops striking signs upon physical examination of the chest which are apt to change in a peculiar manner from day to day or even hour to hour. The changes on the roentgenogram depend upon the bronchus involved, and

FIG. 1. Case I. Mesothelioma of pleura which invaded the bronchus and caused bronchostenosis. Jan. 10, 1921. A rounded shadow with ill-defined margins projects from the mediastinum into the left lung field.

it is to these that our attention will be confined.

Therefore, as far as its physical effects are concerned, it seems well to consider bronchial carcinoma as developing in two stages: 1. Stage of invasion; 2. Stage of bronchostenosis: Characterized by (1) bronchiectasis; (2) infection; (3) atelectasis; and (4) thickening and adhesion of the pleura, with or without fluid.

A study of our cases seems to show that the order in which these changes are listed here is probably the order in which they take place. Whether infection precedes, follows, or accompanies bronchiectasis is a debatable point. These two processes, however, in some cases at least, precede atelectasis, as for example, in Case IV.

Of the 5 cases from the Medical Service of the Presbyterian Hospital, New York City, illustrative of these changes, 4 have been proven by necropsy and by bronchoscopy. The clinical side will be touched upon as briefly as possible.

Case I (No. 48869). Although this discussion deals primarily with bronchial carcinoma, the first case is a mesothelioma of the pleura which invaded the lung and bronchus and caused bronchostenosis with its attendant results, and hence is of interest in the study of changes due to bronchial obstruction.

The patient was a man aged thirty-seven, who was admitted Jan. 27, 1921, complaining of cough and pain in the left chest of three weeks' duration. At the onset he consulted his physician who had a roentgen-ray examination made of the chest.

The first film (Fig. 1), Jan. 10, shows a rounded shadow with ill-defined margins projecting from the mediastinum into the left lung. His pain grew worse, he became dyspneic, lost weight rapidly and began to raise bloody mucoid sputum.

The second film (Fig. 2), Jan. 28, the day after admission, shows a marked advance in the shadow in the left lung field and diminished radiability of the periphery of the left lower lobe. This together with the bloody sputum suggests that invasion and constriction of the bronchus had already begun. It was recorded clinically at this time that the heart seemed slightly displaced to the left. Unfortunately, the rotation to the left on this film is so great that it is impossible to be sure about the position of the heart.

The third film (Fig. 3), Feb. 15, shows an increase in the shadow at the left base and definite displacement of the heart into the affected side which is the characteristic result of atelectasis. About ten days before this was taken the patient developed the physical signs of fluid, and the first of a series of four aspirations was performed, removing 500 c.c. of fluid. At the other

FIG. 2. Case 1. Jan. 28, 1921. A marked advance is evident in the shadow in the left lung field with diminished radiability of the periphery of the left lower lobe. This together with the appearance of bloody mucoid sputum suggests that invasion and constriction of the bronchus have begun.

FIG. 3. Case 1. Feb. 15, 1921. The shadow in the lower part of the left lung is more dense and the heart is displaced to the left, the characteristic result of atelectasis. Shortly before this 500 c.c. of fluid were removed.

FIG. 4. Case 1. March 30, 1921. The entire left lung field is covered by a dense shadow. The heart is approximately in its normal position.

FIG. 5. Case 1. April 18, 1921. The dense shadow covers the entire left side and the heart is again displaced to the left. Between this examination and the one preceding only 600 c.c. of fluid had been removed.

FIG. 6. Case 1. May 20, 1921. The left lung field is opaque and the heart is displaced into the shadow as at the preceding examination.

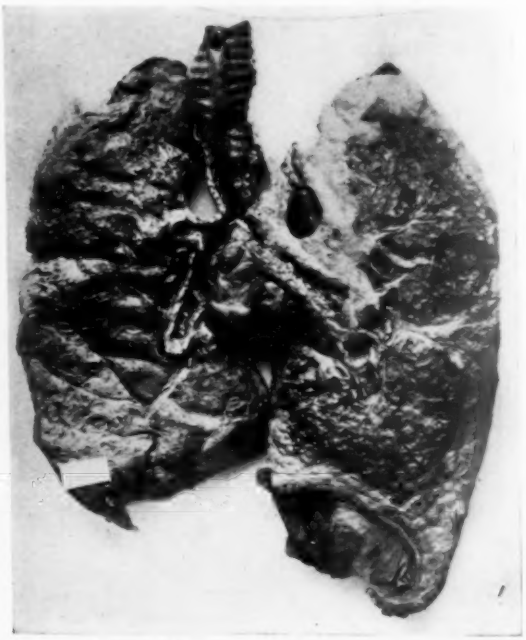

FIG. 7. Case 1. Necropsy July 7, 1921, disclosed a mesothelioma of the pleura which completely occluded the left primary bronchus, filled the mediastinum and covered most of the left lung. All of the bronchi of the lower lobe were dilated and filled with pus. In the upper lobe were two cavities.

FIG. 8. Case II. Slow-growing carcinoma of the right descending bronchus Dec. 29, 1920. A hazy ill-defined shadow is present in the region of the right descending bronchus. The inner third of the right side of the diaphragm is held up. The pleural adhesions at the left base are the result of pneumonia and empyema twenty-five years before this illness.

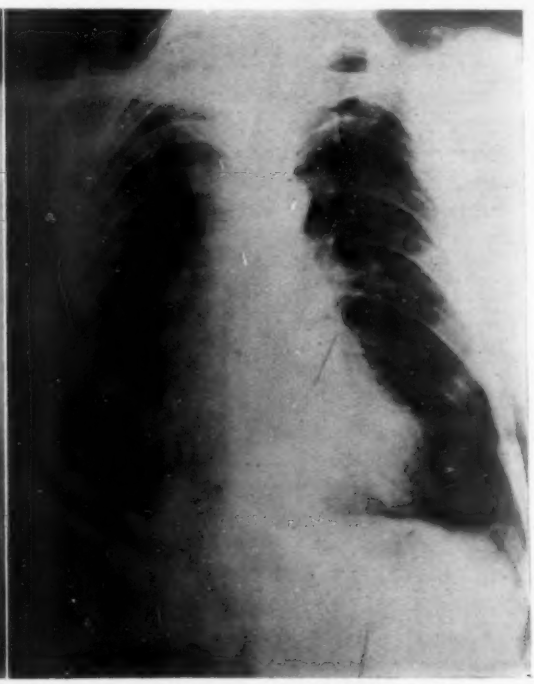

FIG. 9. Case II. Sept. 15, 1921. The shadow in the region of the right descending bronchus seen on the preceding film taken nine months earlier has increased in size. (This print was made from a rather poor contact reproduction and does not do justice to the original film.)

aspirations likewise only small amounts of fluid were obtained.

On March 8 the patient was bronchoscoped. The opening of the left main bronchus could not be found. The right appeared normal. The growth had also invaded the esophagus causing considerable obstruction. On March 15 a film showed the entire left lung field to be obscured.

The fourth film (Fig. 4), March 30, shows the entire left chest covered with this dense shadow with the heart approximately in its normal position. It is difficult to explain this shift in the position of the heart, as the fluid seemed to be present only in small quantities. About five days after this film was taken, approximately 600 c.c. of fluid were removed.

The fifth film (Fig. 5), April 18, shows the heart displaced to the left again, although only the above mentioned 600 c.c. of fluid had been removed.

The last film (Fig. 6), May 20, shows the same displacement of the heart into the shadow covering the left lung field.

Necropsy on July 7 disclosed a large firm mass filling up the mediastinum, continuous with a layer of the same tissue covering most of the left lung and binding it to the chest wall (Fig. 7). The left primary bronchus was entirely surrounded and completely occluded by the tumor. The left lung contained no air. The main bronchus to the lower lobe was dilated and its surface ulcerated. The cut surface of the lung was bathed in purulent fluid. All of the bronchi of the lower lobe were dilated and filled with pus. In the upper lobe were two cavities.

FIG. 10. Case II. March 4, 1922. The shadow at the right base is increased in size and is more dense toward the mediastinum than toward the periphery. A study of the case suggests that the changes associated with bronchostenosis were probably taking place. The band-like shadow across the middle of the right lung field is puzzling. It might be the rather small middle lobe in process of becoming atelectatic. Shortly after this 300 c.c. of fluid were removed.

FIG. 11. Case II. March 30, 1922. The shadow at the right base has become homogeneously dense. It is higher at the mediastinum than at the periphery. The upper part of the upper lobe is obscured and the pleura along the right margin of the mediastinum seems thickened.

CASE II (No. 53513). The second case is one of a slow-growing carcinoma of the right descending bronchus. I am indebted to Dr. L. G. Cole of New York City for the first two films and to Dr. R. D. Duck-

worth of White Plains, N. Y., for the third.

The patient was a man aged fifty-one, whose symptoms began with cough, dyspnea on exertion and what was described as "inspiratory asthma" during the fall of 1920.

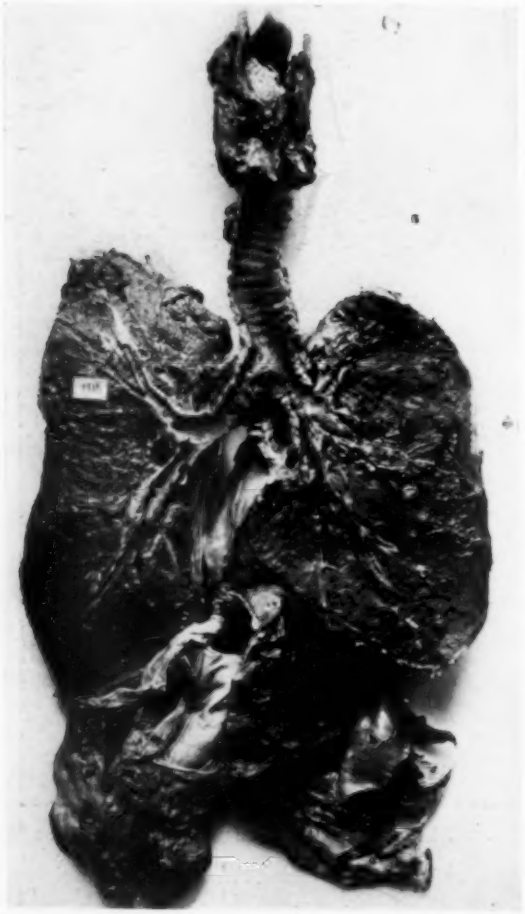

FIG. 12. Case II. Necropsy April 19, 1922. The bronchi to all the lobes were markedly constricted by carcinoma of bronchial origin which contained masses of calcium. The middle and lower lobes were firm and inelastic and contained multiple abscesses. The lung was covered with thickened pleura except at the apex.

The first roentgenogram of the chest was made Dec. 29, 1920 (Fig. 8). There is a rather hazy ill-defined shadow in the region of the right descending bronchus and a holding up of the inner third of the right diaphragm. The old pleurisy on the left is due to a pneumonia and empyema twenty-five years before.

The second film (Fig. 9), September 15, 1921, approximately nine months later, shows essentially the same shadow somewhat increased in size. In February, 1922, he had an acute illness followed by a fever with considerable watery sputum.

The third film (Fig. 10), March 4, 1922, shows considerable increase in the shadow at the right base which appears rather irregular in density, being more dense toward the mediastinum than toward the periphery. Just below the level of the fourth rib there is a band-like shadow of medium density and with fairly sharply defined margins which is rather puzzling. A study of the pathological specimen and of the succeeding roentgenogram suggests that this shadow may be the rather small middle lobe, in process of becoming atelectatic. Shortly after this the chest was aspirated and a small amount of fluid, about 300 c.c., removed.

The patient was admitted to the hospital March 29. The last film (Fig. 11), March 30, 1922, shows a dense shadow at the right base, higher at the mediastinum than at the periphery. The upper part of the upper lobe is obscured by a hazy shadow, and the pleura along the right margin of the mediastinum seems thickened.

Hoping to find an abscess which could be drained a thorocotomy was done. A small amount of slightly turbid fluid was found. The lung did not collapse. Aspiration of the lung itself yielded pus.

Necropsy April 19 (Fig. 12) disclosed a carcinoma of bronchial origin which contained masses of calcium, leading the pathologist to say that it had probably been very slow growing. (The duration of this case was at least a year and a half.) The lung was covered with thickened pleura except at the apex. The openings of the bronchi to all three lobes were markedly constricted and when they were opened pus came from them, especially from the lower lobe. Behind the constrictions the bronchi were dilated. The middle and lower lobes were firm and inelastic and contained multiple abscesses, many of which could be seen to connect with small bronchi.

CASE III (No. 58201). The third case is one of carcinoma of the right upper lobe

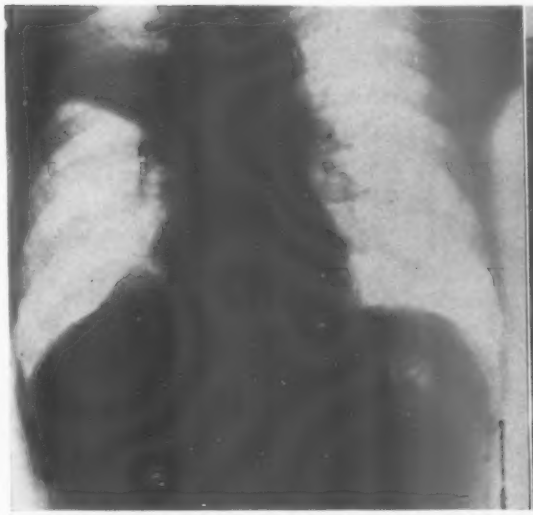

FIG. 13. Case III. Carcinoma arising in the bronchus to the right upper lobe. Aug. 19, 1923. Extending across the right lung field is a shadow, the lower margin of which is sharply defined at about the level of the interlobar septum. It fades off into the air-containing upper lobe which is distinctly less radiable than the corresponding portion of the left lung. It would seem that atelectasis had begun to take place. The inner third of the right diaphragm is pulled up.

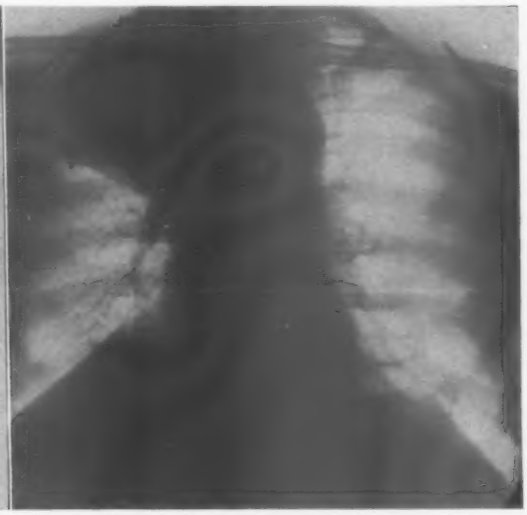

FIG. 14. Case III. Sept. 26, 1923. The area of the right upper lobe is occupied by a dense shadow with a sharply defined concave lower margin. The upper lobe has become atelectatic.

bronchus. I am indebted to Dr. I. Seth Hirsch of New York City for the first and last films. The patient was a man aged sixty-two. His first symptom which appeared in the spring of 1923 was apparently swelling of the face and neck. He was admitted to Bellevue Hospital, August 15, 1923.

The first film (Fig. 13), Aug. 19, shows a shadow in the upper part of the right lung field with a sharply defined lower margin extending from the mediastinum to the lateral chest wall at about the level of the interlobar septum. It fades off above into the air-containing remainder of the upper lobe which is less radiable than the corresponding portion of the left lung. It would seem that atelectasis had begun to take place. The inner third of the right side of the diaphragm is pulled up. This change in the diaphragm has been present in 3 cases of carcinoma of the bronchus to the right upper lobe. Examination of the pathological specimens and consultation with the pathologists has failed to produce an explanation of its mechanism.

The patient left Bellevue Hospital against advice Sept. 2 and about three weeks later came to the Out-Patient Department of the Presbyterian Hospital. He then complained of unproductive cough shortness of breath and loss of weight.

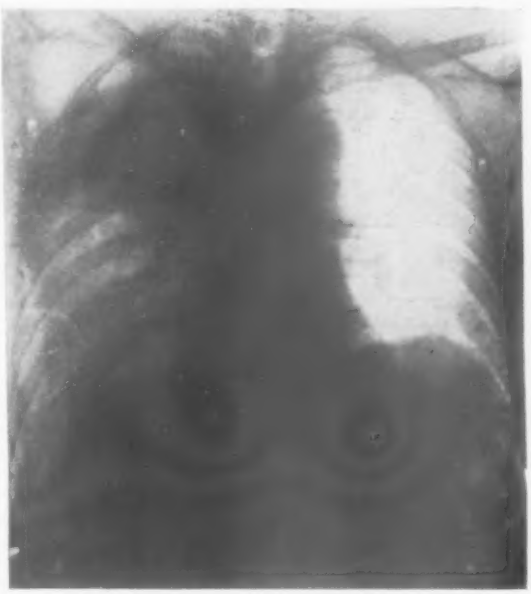

FIG. 15. Case III. Nov. 25, 1923. The shadow in the region of the right upper lobe is unchanged. The shadow of medium, rather irregular density which occupies the lower part of the right lung field was found to be due to bronchopneumonia. At necropsy the carcinoma involved only the upper lobe bronchus. The upper lobe was covered with thickened pleura and contained small bronchiectatic cavities.

The next film (Fig. 14), Sept. 26, shows the area of the right upper lobe to be

occupied by a dense shadow with a sharply defined concave lower margin. He was admitted to the hospital Oct. 13.

A film Oct. 15, and another Oct. 29, showed no essential change except that the lower margin of the shadow in the right lung field bulged downward and became convex instead of concave. Roentgenoscopic examination in various positions showed that the lower margin of this shadow slanted from behind downward and forward, indicating that it occupied exactly the position of the upper lobe.

Bronchoscopic examination disclosed firm-walled tumor nodules involving the lung field is obscured by a shadow of medium, rather irregular density, due to bronchopneumonia.

Necropsy Dec. 7, disclosed a hard nodular mass in the mediastinum surrounding the great vessels, trachea and right bronchus. There were dense adhesions over the right upper lobe. On section of the lung, the bronchus to the right upper lobe was practically obliterated by the growth and tumor nodules were scattered along the right primary bronchus to the posterior wall of the trachea. The growth had invaded the lobe for a short distance as a tongue-like projection along the interlobar septum.

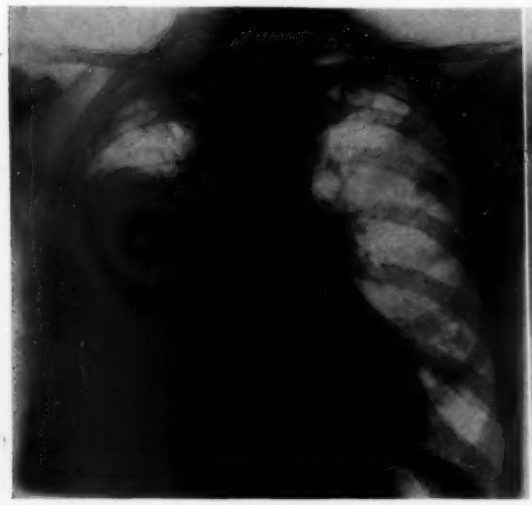

FIG. 16. Case IV. Carcinoma probably arising in the right descending bronchus. March 26, 1924. A dense homogeneous shadow with a well-defined rounded upper margin occupies the lower two-thirds of the right lung field. The right apex is clouded. In the right second interspace are some small rounded or oval shadows of diminished density characteristic of cavities. The trachea is displaced to the right. Four days later bronchoscopy disclosed a growth occluding the lower end of the right primary bronchus. Atelectasis is complete in the middle and lower lobes and is probably beginning in the upper.

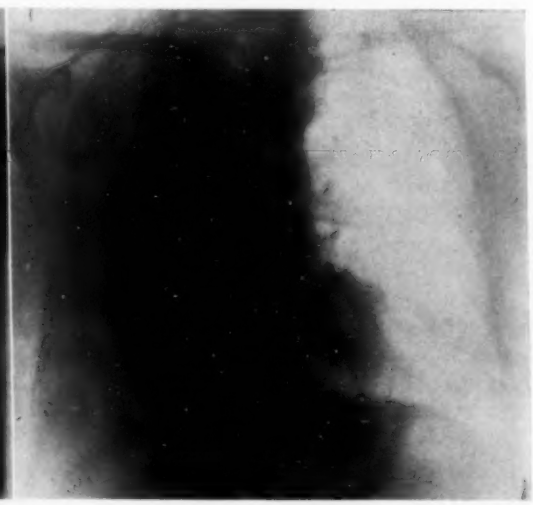

FIG. 17. Case IV. April 18, 1924. The entire right hemithorax is covered by a dense shadow. In the right second interspace the shadows of diminished density probably representing bronchiectatic cavities can be seen. The heart and trachea are displaced to the right. Atelectasis of the right lung is complete.

posterior wall of the trachea just above the bifurcation, the right main bronchus and to a less extent the left. The mouth of the bronchus to the right upper lobe was obstructed. The patient was discharged against advice Nov. 7.

About two weeks later he was admitted to the City Hospital, Welfare Island. The last film (Fig. 15), Nov. 23, shows the shadow in the region of the right upper lobe practically unchanged. Below it the

The bronchi of the upper lobe were dilated and small bronchiectatic cavities were present. There was a diffuse bronchopneumonia of the middle and lower lobes. About a liter of fluid was found in the right pleural cavity. I am indebted to the courtesy of Dr. L. H. Cornwall, pathologist to the City Hospital, New York, and to his associate Dr. J. R. Lisa for the opportunity to examine this specimen upon two occasions.

Case IV (No. 50502). The fourth case is one of carcinoma arising probably in the bronchus to the right lower lobe. The patient was a man aged sixty-six, who was admitted to the hospital March 25, 1924, complaining of pain in the right chest, cough and weakness of six months' duration. He had spit up blood upon one occasion at the onset.

The first film (Fig. 16), March 26, shows a dense homogeneous shadow with a rounded, fairly well-defined upper margin which occupies the lower two-thirds of the right lung field. The trachea is displaced to the right. In the right first interspace are several small rounded or oval shadows of diminished density which suggest multiple small cavities.

The patient was bronchoscoped March 30. The bifurcation of the trachea was displaced to the right. The right main bronchus was clear to about the site of the upper lobe bronchus which, however, could not be identified. Below this the lumen was blocked by a fungating vascular friable growth which looked like carcinoma. These bronchoscopic findings indicate that the mainstem bronchi to all three lobes were occluded.

The second film (Fig. 17), April 18, shows the entire right lung field covered by the shadow. On careful inspection of the right first interspace the small shadows of diminished density described on the preceding film can be seen. The trachea is markedly displaced to the right, as is the heart.

A third film on May 23 showed no change except a little difference in the size and arrangement of the cavities in the right upper lobe. The patient died shortly after this and permission to perform a necropsy could not be obtained.

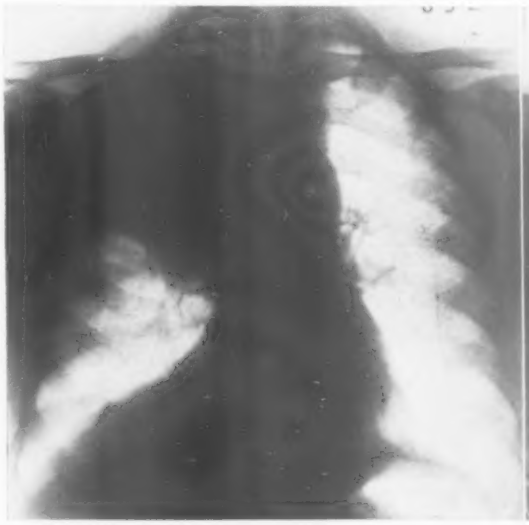

Fig. 18. Case v. Carcinoma of the bronchus to the right upper lobe. Aug. 8, 1923. The upper half of the right lung field is occupied by a dense shadow with a sharply defined lower border which is convex close to the mediastinum and concave toward the periphery. The inner third of the right diaphragm is pulled up.

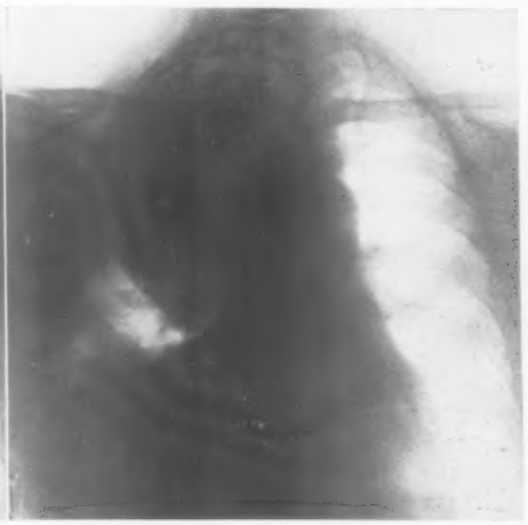

Fig. 19. Case v. Aug. 27, 1923. The lower margin of the shadow in the right lung bulges downward. The marked change in the appearance of this shadow was thought to be due to the retention of pus and secretion in the bronchi and bronchiectatic cavities, causing an actual increase in the size of the atelectatic upper lobe.

In this case, at the time of the first roentgen-ray examination atelectasis of the middle and lower lobes had taken place, and there is evident cavitation, presumably bronchiectatic, of the right upper lobe. At the second examination the right upper lobe had become atelectatic but the small cavities persisted.

Case V (No. 57814). The fifth case is one of carcinoma arising in the bronchus to the right upper lobe. The patient was a man aged fifty-one, who came to the Out-Patient Department complaining of swelling of the head. For three months he had had cough with bloody sputum at times,

and dyspnea on exertion. Six weeks prior to his appearance his face and neck became swollen.

The first film (Fig. 18), August 8, shows a dense homogeneous shadow, the lower border of which is convex medially and concave toward the periphery, occupying the upper half of the right lung field. The inner third of the right diaphragm is pulled up as noted in preceding cases.

He was admitted to the hospital August 25, 1923. The second film (Fig. 19), August 27, shows a marked increase in the downward bulge of the shadow.

Necropsy was performed September 12 and disclosed a carcinoma of the bronchus to the right upper lobe, the lumen of which was so narrow that only a small probe could be passed through it. Beyond the obstruction it was dilated and contained pus. The upper lobe was shrunken and its bronchi dilated and filled with pus. The pleura over the upper lobe was very thick and adherent. The bronchi to the middle and lower lobes were not obstructed.

There is no obvious explanation for this change in the size and contour of the shadow in the right lung field. As the middle lobe bronchus was uninvolved it could not be due to the development of atelectasis of a small middle lobe. The tumor itself extended only 4 cm. below the bifurcation and the same distance to the right of the trachea. The most probable explanation is the actual increase in the size of the upper lobe due to the accumulation of pus and secretion in the bronchiectatic cavities. This would also apply to the change described in the lower border of the shadow in Case III.

SUMMARY AND CONCLUSIONS

The object of this paper is to demonstrate the rather striking changes which may take place in the lung shadows during the course of primary bronchial carcinoma. These are of interest because the impression produced on the mind of the observer may be quite different at different times in the disease.

A study of our cases suggests that, as far as its physical effect is concerned, bronchial carcinoma may be considered as developing in two stages: (1) stage of invasion, and (2) stage of bronchostenosis which is characterized by bronchiectasis, infection, atelectasis, and pleural thickening, with or without fluid.

The hazy ill-defined shadow about the hilus during the stage of invasion may be replaced, as the effects of bronchostenosis begin to manifest themselves, by a dense homogeneous shadow covering the area of one or more lobes, sometimes accompanied by displacement of the heart and trachea to the affected side. Such massive shadows are due to atelectasis of the corresponding lobes with associated bronchial and pleural changes and not to the tumor itself. Hence it is evident that they are not characteristic of bronchial carcinoma but may be produced by any process which occludes a bronchus. Syphilitic stricture and pressure on a bronchus from an aneurysm or from tuberculous glands are other causes of bronchostenosis. During the past three years, however, we have had 7 instances of bronchostenosis due to pulmonary neoplasm, only 2 from syphilis and none from pressure of an aneurysm or tuberculous glands. It would seem from our experience that neoplastic bronchostenosis is distinctly more common.

It is obvious that a correlation of clinical and laboratory information is necessary in order to reach a definite conclusion in these somewhat confusing cases. But when these shadows occupying the position of one or more lobes present themselves for consideration, if the possibility of bronchostenosis due to neoplasm is mentioned, the diagnostic machine will at least be started on the right road.

I wish to thank Dr. Wm. C. Von Glahn for his kindness in placing his pathological material at my disposal. Cases I and II have been reported by him.*

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THE SURGICAL TREATMENT OF ROENTGEN-RAY LESIONS*

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IN 1909,[1] I reported 47 cases of roentgen-ray lesions, 6 benign, 41 malignant, with a thorough and careful pathological study of the lesions by Dr. Wolbach. In 1922, before the American Surgical Association, I reported 107 cases, 44 of which were my own, with an additional summary of Dr. Wolbach's further experience. I made no attempt to review the very extensive literature completely, for I wished to learn the actual end-results. Through the kindness of my colleagues, and my personal reports, the present condition of all these cases is known, and I think this series may be considered to represent a typical picture of the lesions under consideration, and the gradual evolution from benign to malignant disease. This paper will then be a short summary of my conclusions; the actual data and case histories will be reported in Surgery, Gynecology and Obstetrics early next year.

For obvious reasons I found great difficulty in classification, but with some allowance for borderline cases, three main groups finally emerged.

Group I. Lesions resulting from a single massive dose, intentional or otherwise, or a few exposures at short intervals.

To this group the recent introduction of deep therapy will undoubtedly add numerous cases, and I fear that even the thoroughly qualified and experienced roentgenologist will have some catastrophies until the exact dosage, particularly in relation to deep organs, has been determined.

Group II. Cases with chronic diseases, pulmonary tuberculosis, lupus, psoriasis, eczema, and particularly the treatment of malignant disease; with many exposures over a long period.

Group III. Professional roentgenologists, many of them physicians, who used roentgen rays from the beginning, before its dangers and the proper precautions were known.

Some of the cases in Group II have developed lesions very similar to the professional class, though usually on other parts of the body than the hands. One case in particular had monthly treatments over a period of six years for tuberculosis of the lungs, as a result of which she developed all of the chronic roentgen dermatitis lesions, including multiple cancer. I have found that cancer rarely develops in Group I, more commonly in Group II, and most frequently in Group III, the professional class. In this group I have records with some post-mortem examinations of 46 malignant cases, 15 of which were my own. Two died, apparently free from the disease, one of apoplexy, and one of uremia. Twenty were well in 1922, 24 had died of extensive recurrence, or internal metastases. There were 10 shoulder-joint amputations, and one removal of the scapula and upper extremity.

While this mortality of 52 per cent is undoubtedly far too high, as many cured cases of cancer have not been reported, we must always remember that at one time these patients presented nothing but simple painful ulcerations, keratoses or epithelial plaques, hence the vital importance of a decision as to the best treatment of these precancerous conditions and of the early lesions which have already become malignant. At this point I wish also to emphasize the common occurrence of a so-called *latent period* between the last exposure and the development of ulceration or yellow gangrene. Usually this interval is not longer than a few months, but in several of these cases this latent period has been prolonged for three or four years after the last treatment. So also with cancer, frequently a long time elapses between the last unprotected exposure with the usual chronic roentgen-ray lesions, more or less quiescent, and the eventual malignant degeneration. The longest time in this series was seventeen years. It was at first thought that roentgen rays chiefly affected the epidermis; then came a more thorough

[1] The surgical treatment of *x*-ray carcinoma and other severe *x*-ray lesions, based upon an analysis of forty-seven cases. *J. Med. Research*, 1909, xxi, 357–413.

* Read at the Twenty-fifth Annual Meeting, AMERICAN ROENTGEN RAY SOCIETY, Swampscott, Mass., Sept. 3–6, 1924.

understanding, from the work of Wolbach and others, that the deep skin and subcutaneous tissue received the brunt of the injury, and that a permanent endarteritis, often progressive, resulted, which, with the obliteration of lymphatics and the formation of deep scar tissue, explained this so-called latent period. The anemic gangrene which develops in these cases is peculiar in that no definite line of demarcation forms as in ordinary anemic gangrene, but there seems to be sufficient vascularity to keep the part from dying outright, while there is inadequate reaction on the part of the surrounding tissue to cast off the slough. Above such deep lesions are the exquisitely painful and sensitive ulcerations covered by the characteristic yellow fiibrinous membrane.

There are superficial ulcerations which will heal in time under many treatments, or in spite of all treatment, but from my experience, I would absolutely interdict all irritants, all caustics, even all antiseptics unless there is well-marked infection. Protection from the air is essential on account of the pain and is best obtained by a neutral powder, such as stearate of zinc, covered by an occlusive dressing, with elevation and immobilization of the part. A paraffin or ambrine dressing, though difficult to apply, meets all of these indications. Simple hot saline compresses, covered with some impervious material, often give relief, and seem to promote healing; local anesthetics, while occasionally necessary, I believe to be harmful, particularly orthoform. Where many more or less acute lesions exist on the hands or face, such palliative treatment may be tried for a certain period, but in other parts of the body I believe in early adequate excision, not only because it brings immediate relief from the excruciating pain, but because it is the surest, quickest, and most permanent cure for the condition. My only exception to this rule is in cases where such excision would involve important structures, nerves, arteries, tendons, etc., or the whole thickness of the abdominal or chest wall. Under these circumstances as much of the affected tissue should be cut away as one dares, and the remainder of the wound must be left to granulate if it will. In general, the tendency is too conservative, and the lesions are more extensive than at first appear. This was shown particularly well in one of my cases where I thought I had made an adequate operation, but Wolbach reported that the disease was more widely spread, proven, by further necrosis as late as seven years afterwards. After excision, depending upon the condition of the base of the wound, immediate skin-grafting may be done, or this may be deferred until granulations have filled in the defect. With few exceptions I am averse to sliding flaps or plastic operations, owing to the danger of sloughing in the flap from the wide-spread endarteritis. The extent of some of these lesions has been frightful, involving the whole of the front and sides of the neck and the chest, down to the nipples in one case, the whole of the anterior abdominal wall below the umbilicus, and down to the peritoneum in several cases; sloughing of almost the whole of the left side of the face, followed a single exposure for impetigo in another instance. I have had two patients, one with the palms of both hands deeply ulcerated, following treatment for psoriasis, and the other with the soles of both feet, treated for the same condition. A fatal case reported to me by Archibald of Montreal after radium treatment suffered from a huge ulceration in the splenic region which demanded a low thoracic resection with much of the upper abdominal wall.

In advocating early operation in these acute or subacute lesions, I have had regard merely to relief from pain and a cure of the condition. The characteristic pain is due, I believe, to exposed nerve endings in the base of the ulcer, to a localized neuritis and to compression of the nerves as the scar tissue contracts. The almost invariable and complete relief from pain which follows adequate excision proves that the neuritis has not extended beyond the involved area.

TREATMENT OF INFECTIONS IN CHRONIC ROENTGEN-RAY DERMATITIS

You all know how frequent are the intermittent infections of the hands of

men who will keep on their jobs, especially in winter, when cracks and fissures are so common; and about certain keratoses which are frequently irritated by pumice stone or caustics, and most particularly about the nail beds where a condition quite similar to an ingrowing toe-nail occurs. Some patients do well with hot antiseptic soaks, for which I prefer carbolic (1–50 or 1–100) with rest and immobilization. Others do well with dry treatment, water seeming to macerate the tissues, making a bad matter worse; others again are comfortable under a mild antiseptic ointment. There is no rule—each individual has usually learned from his own experience. This much seems clear to me, that recurrent nail infections demand complete removal of the nail and extirpation of the nail bed—a delicate and difficult operation, as subsequent partial regeneration of the nail so frequently shows. Chronic fissures are best cured by skin-grafting.

KERATOSES

Keratoses, particularly if ulceration has ever occurred, should be destroyed. How best I do not know. I do know what excision and suture or skin-grafting will accomplish, though this means often multiple operations, splints, and ten days of treatment. The majority of roentgenologists seem to prefer sparking, carbon-dioxide snow, electrocoagulation or radium. With them I have no quarrel; so long as the lesion is completely destroyed and sound healing results. I do not doubt that in many cases the results of such treatment are satisfactory, with this great benefit, that there is no detention from business, but I must state most emphatically that I have seen many cases in which the result of such treatment was not satisfactory, and in my judgment the simple operation of excision and grafting has been delayed too long. When we come to the treatment of chronic intermittent or persistent ulcerations on the hands of roentgen-ray workers in which there is a reasonable suspicion of malignancy, I wish frankly to take issue with any other than surgical treatment, and hope to arouse enough discussion to settle this point, for it is the meat of the whole question. If certain cancers can be cured by roentgen ray, radium and electrocoagulation, which is undoubtedly true, is there any valid objection to the employment of these agents in roentgen-ray cancer? Personally I have never advised roentgen ray or radium, for such ulcerations, fearing further damage to the already injured tissue, and believing that the surrounding endarteritis is the cause of the persistent ulceration. These theoretical objections would not obtain with electrocoagulation. While the diagnosis of cancer is clinically obvious in many cases, there are others, particularly when the lesions are multiple, in which a positive diagnosis, without the microscope, is impossible; even then the report is sometimes uncertain, and the pathologist states that the lesion is precancerous. Not infrequently a question arises as to whether the ulcer is fixed to the deeper tissues by malignant infiltration or by chronic inflammation. While many superficial cancers limited to the skin have been permanently cured by local excision and grafting, I believe a cure would also have resulted from their destruction by electrocoagulation, the actual cautery, or radium, but is the subsequent healing as quick or permanent as after excision and grafting? Are these presumable cancers so treated really proved cancers? In a case of proved cancer adherent to the deep tissues or periosteum of a finger, are we willing to advocate any other treatment except amputation? Is there any good reason to believe that if a proper tourniquet has been previously applied there is any risk of scattering cancer cells by a wide excision or an amputation? I believe not, and I feel that it is of vital importance that we should know definitely the pathology of the lesion in question. As I have followed many of these cases from year to year, there have first been simple ulcers and then very insidiously the ulceration has taken on a different character and has become persistent and deeper. In spite of all warnings the patients have neglected themselves and failed to report until the lesion was no longer limited, and glandular metastases had occurred. Here again though the valuable effect of roentgen rays and radium on malignant glandular

metastases is undoubted, I trust I am not too surgical if I express the positive opinion that if regional glands were known to be involved in malignant disease, starting in the hand, I should first prefer radical surgical operation and then subsequent radiation, and would not be willing to trust the epitrochlear or axillary glands as a first choice to radium or roentgen therapy. As to whether such treatment should be employed previous to operation, I am not yet clear. The situation in the cases under discussion is different in one respect from, let us say malignant disease of the breast in which I think all agree that thorough removal of the breast and overlying skin, followed by a radical axillary dissection is routine treatment. Here the more radical the operation, the better the results. The problem with roentgen-ray cancer is somewhat different, for owing to the frequent infections in these cases we almost always have some enlargement of the epitrochlear and axillary glands. Is this due in a given case to chronic adenitis or to metastases? If we remove the glands and they are found not to be malignant, we have opened up a path, should subsequent cancer develop, for the cells immediately to enter the general circulation. If a malignant lesion has occurred on one part of the fingers or hands, it is probable that in subsequent years others may develop. Therefore, if there has already been a glandular dissection the patient should be urgently warned that any subsequent lesion which is suspicious should be treated immediately.

DISCUSSION

Dr. Porter opened the discussion with the following supplementary remarks:

My point is this, that in ordinary malignant disease if we get rid of both the local lesion and the glands, we will cure the disease; but in these roentgen-ray cases I think we should preserve the guardian glands as long as we dare, for they are very often simply enlarged from adenitis and to a certain extent prevent the metastasis of cells to the rest of the body. That is a difficult point to decide and in each case one must form his own judgment. I suppose in the long run, when in doubt, the safest thing is to operate, and, as I have said, to warn that patient that he must give immediate attention to any suspicious lesion that develops later.

Now in regard to the operations that I have done, on many of these cases I have developed a new technique for skin grafting—I don't mean new, but a different one from the ordinary one, and the reason for it is this: Where there have been multiple ulcerations on the hands, I have given gas and oxygen and always after application of a tourniquet have excised the lesions. I have then applied simple sterile bandage cloth, with pressure and a splint. That operation takes a very few moments. The specimens are then carefully marked and given to the pathologist, with a diagram, and at the end of a few days his report is ready.

I then give gas and oxygen again; remove the bandages; wash the wounds with salt, and in a very few moments the bleeding stops, and I can apply the grafts. The reason for this technique was that previously I would have to wait sometimes an hour for the bleeding to stop after excisions, for the vasomotor system in these chronic dermatitis cases seems to have ceased to function and they bleed very freely; and if there are a number of grafts to put on, an ooze will occur under one and float it off while another is being put on. I have had none of that trouble since resorting to this two-stage operation.

There is also this advantage: That as many of these cases occur on the back of the fingers and hands, when we do a proper excision of a doubtful ulcer, we very frequently come down upon the white, glistening aponeurosis or a tendon sheath. Now a graft would not take on that, if applied immediately, but if we wait for several days, granulation has commenced, and the graft will usually take. We would like to wait in some of these cases for a week, but the objection to waiting too long is that there is always about the edge of the excision, no matter how carefully dressed, some infection which jeopardizes the graft.

I feel, therefore, that when the majority of these patients have finally come to me, I would not be willing to advocate destruction of these lesions. I don't think it matters much as long as you destroy either the lesion or the cancer, but a patient will be more careful to watch for glandular metastases if he knows he has a cancer, than if he has had merely some superficial ulcer that has been destroyed by some other method. It seems to me that keratoses are very rarely malignant in the beginning and any method that destroys them is adequate.

In regard to another point, I believe that the more we examine these tissues which have been

treated by deep therapy or by frequent deep doses, we will find that the roentgen-ray lesions are not limited to the skin but are scattered throughout the adjacent soft parts, and in all operations which I have done on irradiated skin there has been an interference with the healing; a tendency for the stitches to cut through; and to form ulcerations.

I hope that there will be a free discussion; my views may be too radical, but they are backed by a very considerable experience.

Dr. E. A. Codman, Boston. I have followed Dr. Porter's work ever since he started it. I have had the advantage of seeing many of his cases, and year by year seeing how he advanced in the treatment of them.

I do agree, very heartily, with his general conclusion that excision of suspicious ulcerative areas is much wiser than tampering with them, even to gain valuable time.

With regard to the pathology of these roentgen-ray lesions, it is easier for me to study any malignant tumor if I consider it as a form of irregular healing or irregular repair, or a change in growth. All organisms, including the human, grow according to some law, and there is some definite place where that growth stops. It is something that we inherit which indicates to the smallest detail where that growth must stop. Furthermore, we have during life the changes of function of activity. There are the various developments connected with the glands; the phenomena of pregnancy, for instance, have to take place according to certain laws. Now, we are subject to all sorts of injuries from the outer world. Whenever a tissue is damaged, it is repaired. If that repair fails to take place normally, or that growth fails to grow normally, it may be malignant. In other words, malignancy is an interference with the law of assembling; growth takes place in an abnormal way; it loses its check. So I believe malignant disease is an absence of the normal check to tell repair when it is finished.

In regard to the roentgen-ray lesions, here is a lesion which we have never by heredity learned to repair properly. Our ancestors developed the power to repair all the wounds inflicted by natural agents, but the roentgen ray never was present until within our own day. There was practically no radiation trauma in nature to which man has been exposed. We have had to dig it out of the earth in small quantities and put it together, or make it with the electrical machine. Consequently, the human being has no power to repair that lesion. We break a bone and it repairs within a few weeks or a few months. With the roentgen-ray lesion, that is not the case.

In regard to the technique, I have had the opportunity to see many of Dr. Porter's cases where he has performed these miracles. I have no personal experience to add in this matter of the skin grafting art, but during my first years of work with the roentgen ray I had keratoses, which I had removed by radium very successfully, so I should like to say that for small keratoses I am rather in favor of radium treatment.

Dr. James Ewing, New York City. I have followed the papers this morning with a great deal of interest. Of course, we are all familiar with the pioneer work of Dr. Porter and Dr. Wolbach on this subject, but it is an additional pleasure for me at least to have listened to the presentation of the work itself, and to see the enthusiasm and the detail with which the authors present their points.

I am not competent to speak from the clinical side, but would wish to express my admiration for the very great skill which Dr. Porter has shown in dealing with these most unfortunate victims of radium burns.

It has always appeared to me to be a lack of reason to attempt to cure by radium a keratosis or a carcinoma produced by roentgen rays and yet it appears that it is sometimes successful, as Dr. Codman has just reported in his own person. I have often thought, however, that there was some matter of importance to be drawn from that experience. If you can cure a keratosis, a beginning carcinoma by irradiation, then it would appear that the amount of damage to the subcutaneous tissue must be less than the amount of stimulation to the epithelium, because if you added radium effects to the damage to the connective tissues already produced by the roentgen ray, then you would have a worse condition than you started with; whereas the radium applied properly undoubtedly clears up many of these keratoses and some beginning carcinomas. So I think that fact indicates that in many of these beginning carcinomas the initial and prominent factor is not found in changes in the subcutaneous connective tissue but in the excessive vitality and normal activity of the epithelium cells.

Dr. A. L. Gray, Richmond, Va. There are several points that I would like to ask Dr. Porter to bring out. First, I should like to ask what the dosage was, if he can give it to us, that produced these lesions; especially the one on the back of the hand and the palm of the hand. We don't want to have any more of them if we can help it.

Dr. Porter. I don't know. It has been very difficult to find out, because most of those were not done by very reputable roentgenologists.

When you come to defining the dose, you come to an impasse.

Dr. Albert Soiland, Los Angeles, Calif. I believe the lesson given us this morning by Dr. Porter should be carried home and thoroughly discussed by ourselves in our work. It shows strongly our responsibility to our patients when we have in our hands the ability to produce such lesions as these. I think the greatest thing we have to fear is the possible results of short ray therapy with which we are not as yet at all familiar; fortunately, it appears that the short high voltage rays do not do so much visible damage, but what the invisible damage will be, we will have to learn.

In regard to the so-called latent reactions, Dr. Porter spoke of lesions appearing several years after radiation. I think Dr. Pfahler saw with me in my office a few weeks ago two patients: in one the lesion occurred six years after the last roentgen-ray exposure to the abdomen; and in the other the lesion appeared five years after the last roentgen-ray exposure of the chest. These patients had five- and six-year periods of absolutely no signs of skin irritation and suddenly a large, necrotic ulcer appeared on both these surfaces.

Surgery is out of the question in the chest condition because the entire chest is involved. In the abdominal case surgery is indicated; the patient has refused surgery, and we are doing the best we can with the treatment which Dr. Porter has given us.

With regard to the treatment of roentgen-ray cases by radium, I think that is positively criminal. Of course, roentgen-ray keratosis is a different thing; that can be treated successfully by radium.

Dr. A. H. Pirie, Montreal. In the early diagnosis of malignancy in a chronic roentgen-ray keratosis, Dr. Porter mentioned that the surgeon considered the gland in a certain case was not malignant because it was so painful. That is a point which I think is very important in the early diagnosis, namely, that pain in chronic roentgen-ray keratosis *is indicative* of malignancy.

I had a case of keratosis that I felt convinced was malignant. Our senior surgeon examined it. From the fact that it was extremely painful on examination the surgeon considered it to be inflammatory and not malignant and recommended that it be not removed. I had it removed, however, and it proved to be malignant. I would say that early malignancy is often not painful, but in this case and in the case of the gland which Dr. Porter described to us, it was painful in a way which we do not usually encounter. Some cases, of course, are not so painful as others.

Dr. C. G. Lane, Boston. As a dermatologist, I have been interested in what Dr. Porter has had to say about the treatment of dermatological conditions, and I have another case to add to that group which he has reported. It is the case of palm of the hand which I saw, with an extensive slough covering the whole palm, resulting from one treatment for a fungus infection of the palm.

I believe that these facts make it necessary for all of us to emphasize at every possible opportunity the necessity for the standardization of our apparatus and technique, and not only that but also the frequent check-up by ourselves personally, of such standardization, particularly if the actual operation of machines is done by technicians. I believe that is a very important fact.

Not only that, but it is also necessary to be sure to avoid the application of other substances, either before or during the use of roentgen rays. MacKee and Remer both emphasize this, and I think that still more attention should be paid to the necessity of omitting applications for at least a week or ten days previous to dermatological therapy and also during the period of treatment.

Dr. B. C. Darling, New York City. I want to ask Dr. Porter to clear up, for me at least, the mechanism of a tourniquet; whether you put the first inch above the operative field or not, and just how do you believe that that protects against metastases? It would seem to me that in the cells in the tissues surrounding the trauma caused by the operation, as soon as you restore the circulation (lymphatic or otherwise) you let these little seeds scatter in spite of all you had done.

Another thing is the clearing out of the axillary glands, or other glands. I believe you said that that would open the road into the general circulation without any screening or sifting, so to speak. Now, if the channels are through the lymphatics and these were obliterated, how would you handle that?

Dr. Porter. I don't think it matters much where the tourniquet is put on, my idea being merely that while one is going through the slight trauma of excision with a sharp knife, there should be no circulation going on. It is the same way with pyogenic infections: if one puts on a tourniquet before opening a boil, none of those organisms can enter the lymphatics; there is no circulation going on.

If the glandular filters are removed by an operation, that lymph must return, and returns not through those glands but by side channels to the highest point above that the lymph can go. For example, we never know exactly with the epitrochlear gland; usually an infection

that starts on the dorsum of the hand will go in a definite streak right through the epitrochlear gland. If that gland has been removed by operation, that lymph will go up to the axilla. If the axilla has been thoroughly cleaned, then that lymph must go around not through the axillary glands but by side channels.

REMARKS ON THE DELAYED OR REMOTE APPEARANCE OF X-RAY BURNS AFTER LONG PERIODS OF LATENCY*

BY RUDOLPH MATAS, M.D.

NEW ORLEANS, LOUISIANA

I CANNOT allow this opportunity to pass without a word of appreciation for the admirable work that Dr. Porter has done and is doing for the profession in his continued studies on *x*-ray burns and in the treatment of this unfortunate class of patients. His contributions to the subject have been of great interest to me, and I cannot thank him sufficiently for the benefit that I have derived from them.

There is one phase of the discussion that I would like to touch upon. This refers to *the delayed or remote appearance of x-ray burns after long periods of latency*. We are all familiar with the classical degenerating and destructive effects of *x*-ray or radium radiations which we designate in general terms as *x*-ray burns or radiodermatitis, but the appearance of these effects after lengthy periods—two, three or four years—have elapsed, and the patients have recovered from the immediate effects of these radiations, are not so familiar or easily explained.

I had the misfortune of making my first acquaintance with *x*-ray burns many years ago, in the early nineties, when radiotherapy was still in its infancy and when this mode of treatment was practiced largely in an empirical fashion with no precise scientific data in regard to screening or dosage to guide us. I have two patients in mind who came under my observation at that early period whose experience illustrates most strikingly the *latent* or long-delayed effect of radiotherapy. In these, the injurious and destructive lesions caused by the rays on the skin and subdermal tissues did not appear until three or four years, respectively, *after* the roentgen therapy had been discontinued and the patients had recovered from its immediate effect. In view of the extraordinary length of the period of latency, the comparative rarity of such cases and the unsuspected dangers that they reveal, they are worthy, I believe, of special mention on this occasion. One of these two experiences goes back to 1901.

A young woman, Miss A. P., aged twenty-five years, of a very fair, blonde type, came for the treatment of a typical advanced exophthalmic goiter, with all the characteristic neck, eye, cardio-vascular and neuropathic manifestations. She was subjected to a systematic course of radiations, generated by an old-fashioned static machine and delivered by a hard tube without screening. Unfortunately the precise focal distance, duration and other technical details have not been recorded. Suffice it to say that the patient was treated serially, at intervals of months between the exposures, for three years. The treatments were always stopped when the characteristic erythema appeared.

At the end of the third year the thyrotoxic symptoms had ceased, the exophthalmos and ocular signs had subsided, the goiter had been reduced to normal and the cardiovascular symptoms had completely abated. A cure, seemingly, had been effected. The skin of the neck, chest and breasts, as far as the nipples, had undergone some atrophic

* EDITOR'S NOTE: Read before the American Surgical Association and published in the Transactions of that Association for 1923. It is republished here with the consent of the author, and because of its importance in relation to the preceding paper of Dr. Porter.

changes and characteristic telangiectatic streaks crossed the field of radiation at various places.

Apart from these relics of her treatment the patient remained well for nearly *four* years (October, 1907), when the skin of the neck became thickened, infiltrated and patches of gangrenous dermatitis appeared. These patches coalesced and spread over the whole area of radiation, from the chin to the midsternum and the upper surface of the mammae to the nippleline and laterally to the clavicles and costal cartilages. By January 16, 1908, she began to display toxic (septic) symptoms —delirium, stupor, fever, albuminuria with involuntary micturition and defecation— with correspondingly weak and rapid pulse. The general aspect of the patient suggested an atypical form of meningitis. There were no exophthalmic signs, no enlargement of the thyroid suggestive of a relapsing thyrotoxism—at least of a Basedow type. The patient remained in an uncertain condition for six weeks, when she gradually regained consciousness and strength and was finally transferred from the hospital to her home, by the end of the ninth week. In the meantime the ulceration in the neck and chest had come to a standstill; the sloughs had been cleared away and the foul, ichorous secretion had greatly diminished, but there was no attempt at healing. An attempt to promote healing by implanting a number of pin-grafts was made five months after the patient's return home, but this failed and the ulceration continued intractable, though much better defined and circumscribed. It was not until July, 1910, two years after the first attempt, that Dr. Smyth, her attending physician, succeeded in healing the whole ulcerated area by excising the entire area of damaged skin and covering the raw surface with sliding flaps and Thiersch-grafts. From this on the patient made an uninterrupted recovery, and, with the exception of an intercurrent attack of appendicitis, remained well and completely free from thyrotoxic symptoms or from recurrence of the ulceration.

Seven years after her recovery from the *x*-ray burn the patient married and has remained well.

In this way the profound toxemia which coincided with the appearance of the ulcerative radiodermatitis, and which threatened the patient's life for nearly six weeks, is a notable and singular feature with no parallel experience that I can find in my search through the literature.

The second case exhibited a similar period of latency, but was not so fortunate in its termination.

The patient, Mrs. S. R. P., a widow, aged fifty-eight years, of a dark brunette type, was operated for an advanced carcinoma of the left breast, with axillary metastases, in 1903. A radical axillomammectomy on Halsted lines was performed, the pectorals were removed with the breast and the denuded chest was covered with sliding flaps. She recovered uneventfully from the operation, leaving, however, a long scar area with a thin covering of skin adherent to the ribs. Prophylactic roentgenotherapy (unscreened) of the whole field of the operation was instituted in series, which continued at intervals for three years (1903–1906). The radiations were discontinued whenever a distinct erythema appeared. The patient remained well for *three* years after the last radiation, when suddenly, in 1907, a gangrenous dermatitis appeared in patches over the radiated areas. These patches coalesced and left a large ulcerated area, which broke down the whole line of the scar. Intense burning pains began with the appearance of the dermatitis, which continued with remissions and exacerbations until her death, which occurred in the present year (1923).

The ulcerated areas were rebellious to all treatment and the pain and intense itching were so severe that codein and then morphia had to be given freely to relieve her. It was impossible to excise the ulcer and diseased area, as this would have necessitated a resection of the chest wall and there was no available sound skin anywhere in the vicinity to permit a closure with flaps. As the ulcer contracted its edges became callous, horny in places and under these horny concretions an epidermoid carcinoma developed which was indolent and was only partially relieved

by radium. However, the patient gradually grew weaker from malnutrition, marasmus and exhaustion and died.

The original cancer of the breast (an adenocarcinoma) did not recur. The small epidermoid carcinoma which appeared in the scar eighteen years after the amputation of the breast only contributed in a small way to her death. The real cause of death was the protracted septic suppuration, ulceration, pain and malnutrition complicated by chronic malarial toxemia, all combining to undermine the resistance of the patient, who had now reached the age of seventy-eight years.

The recent roentgenological literature records a considerable number of interesting illustrations of delayed *x*-ray burns, but very few in which the period of latency has exceeded more than a few months. In fact, until quite recently, I thought that the two cases just reported had surpassed all others in the great length of the period of latency. However, I have since found a parallel case in which the appearance of the dermal lesions (radiodermatitis followed by intractable ulceration with all the characteristic signs) was delayed fully four years after the patient had recovered completely from a bleeding uterine fibromyoma which had been successfully treated by radiation. The case is reported by Dr. Karl Grasmann, of Munich, in the *Deutsche Zeitschrift für Chirurgie*, 1923, No. 1–2, clxxix, 115–129, and is utilized by the author as a text for a most thorough and excellent contribution to the subject of delayed *x*-ray burns. The history of this patient is described with the most precise technical details which clearly show that *x*-ray burns may make their appearance in the field of radiation after extraordinarily long periods of latency; furthermore, that these remote destructive lesions may occur in spite of the most carefully screened and dosed exposures administered by expert radiologists. In the case related by Grasmann the technique adopted was seemingly irreproachable, as shown by the detailed radiological protocols which were kept on file at the Roentgenological Institute of Munich. The treatment was begun in May, 1916, and the patient was discharged apparently well in July, 1916, after undergoing a series of four intermittent radiotherapic sittings applied by cross-firing over the abdominal wall and back and over well-plotted fields. When the patient was discharged she showed no dermal lesions or signs of any injurious radiodermal reactions. Nevertheless, the patient returned in April, 1920, *four* years after her discharge, with a typical burning dermatitis in the buttocks and lumbar region, which was followed by ulceration in the right buttock below the level of the sacroiliac synchrondrosis. At first the appearance of these ulcerative patches led to many conjectures as to their cause, but the appearance of the typical ulcer and the associate lesions revealed its true character. The ulcer resisted all forms of topical medication until it was finally excised in June, 1920, when the patient was cured. Complete recovery was confirmed two years after the operation in the summer of 1922.

Grasmann's report of this case is made especially valuable by a very thorough histologic study of the excised tissues by Prof. Duerck, which shows conclusively that the underlying pathology of these long-delayed and necrogenic *x*-ray burns is a progressive proliferative endarteritis which obliterates the arterioles of the derm and subdermal connective tissue, leading to a gradual but fatal ischemia and nutritional disturbances in the radiated field. Whether this endarterial obliteration is initiated primarily in the endothelium of the arterioles and capillaries or is secondary to correlated changes in the perivascular connective tissue is not fully determined, but the fact remains that the mystery of this long period of latency is explained by the slow but progressive obliteration of the vessels which continues indefinitely once the endothelial proliferation has been started by the penetration of the rays.

Now as regards the treatment of these notoriously rebellious radiodermal lesions, my experience fully confirms the general observation that once an *x*-ray burn has advanced to ulceration, practically nothing will accomplish its cure but a total excision of the entire diseased area, provided this

can be covered by healthy well-nourished flaps or by grafts applied to a perfectly healthy base. However, much can be accomplished by the relief of the intolerable pain that is peculiar to these burns, and even the healing may be promoted and obtained in the more superficial ulcerations by suitable topical applications. Of these I may state that, in a recent experience with several cases of radiodermatitis caused by *x*-rays and by radium, with superficial necrotic ulceration, I have obtained the most satisfactory results by the use of Fischer's fluid, now known by the trade name of "incitamin." This fluid has given almost immediate relief to the pain and has also cleared the ulcers of sloughs and promoted healing in a way that is far superior to the many local applications which have been hitherto recommended. I first became acquainted with this remedy through an article published in the *London Lancet* (October 29, 1921) by Dr. J. L. Fischer, Director-General of the Municipal Roentgen Clinics of Copenhagen, Denmark. It purports to be a compound of horse serum, treated with trypsin, freed from coagulable substances, horse saliva and carbolic acid (0.5 of 1 per cent) as a preservative. The exact mode of manufacture is not given, and in this sense it is a proprietary article. It is applied directly to the diseased surfaces as a gauze compress soaked in the fluid and kept continuously moist by covering with fine rubber or oil-silk tissue kept in place by a retentive dressing. The dressings are renewed morning and evening or as often as may be required to prevent the accumulation of secretions and to relieve pain. It is non-toxic and non-irritating to the skin, and the patients for whom I have prescribed it have all expressed great relief from its immediate soothing effect. It clears these usually foul ulcers from sloughs and keeps them clean and in better condition to heal. It is applicable to all chronic indolent, intractable ulcers, including chronic painful varicose ulcers and malignant cancerous sores. It is especially valuable in *x*-ray and radium burns, for which it was originally devised. While it is not claimed to be a panacea for all chronic ulcers and has no specific virtue, it is a palliative analgesic and antiseptic agent of undoubted value as an adjunct to other surgical and more radical methods of treatment that may be indicated. In the superficial radiodermal lesions it promotes healing far more effectively and pleasantly than any other application we have tried thus far. A central agency has been established by the sale of this article in Chicago, and it can now be obtained from the leading druggists.

ELECTROCOAGULATION OR DESICCATION IN THE TREATMENT OF KERATOSES AND MALIGNANT DEGENERATION WHICH FOLLOW RADIODERMATITIS*

BY GEORGE E. PFAHLER, M.D.

PHILADELPHIA, PENNSYLVANIA

THERE is probably nothing more distressing in medicine than the keratoses and degenerations which develop long after excessive exposure to roentgen rays or radium. The untimely death of a number of our colleagues who were pioneers in this specialty of medicine is convincing proof of the seriousness of this condition. I believe that the lives of all of these men could have been saved if they have been treated early by this method, and if they had used the precautionary measures which we observe today.

The small keratoses of the skin are most commonly seen on the hands and faces of roentgenologists who were exposed excessively during the early days, when the dangers were unknown and the means of protection not yet developed. Most or all of us who began work with radiation about twenty-five years ago have suffered more or less from this condition. I have removed at least one hundred from my own hands and today they are entirely clear. One of these had been removed surgically in 1912, and was found by microscopic examination to be an epithelioma. A recurrence developed which was successfully treated by electrocoagulation.

No description of this disease is necessary. The picture is familiar to everyone. There may or may not be an erythema, but sooner or later the skin becomes smooth and glossy; it loses its velvety appearance; the nails become thin and brittle and break or split. Then small scales or crusts or perhaps warts or corns develop. The oil glands have been destroyed, and if the hands are not kept lubricated, fissures will develop. Any of these lesions may become malignant, if allowed to continue. Where they do become malignant they are, so far as I know, always of the squamous cell type and therefore serious. They may give rise to metastases and result in death.

Therefore the time to treat these lesions is at their beginning. When atrophy of the skin is shown, much can be accomplished by lubricating the skin after every washing of the hands or face. For lubrication, lanolin is the best, or instead of this, which is often sticky and unpleasant, good cold cream applied while the hands are wet, and then thoroughly dried will do much good. While lubrication at night is especially important, it is not sufficient, and should be attended to repeatedly during the day.

The condition is very similar to the keratoses which develop on the skin from other long continued irritation, such as from exposure to the sun and wind in the case of farmers and sailors. The difference is that we are dealing with a more penetrating ray and therefore the damaging effects are deeper. Most of us have suffered from the effects of unfiltered roentgen rays. Therefore our effects are relatively superficial as compared with the deeper degenerating effects developing from excessive use of the filtered rays. No one should get the idea that harmful effects cannot follow excessive exposure to the filtered rays.

Indications for Treatment by Desiccation. Desiccation, as was originally described by William L. Clark, consists of an electrical spark through air from the point of a small needle, excited by a high frequency Oudin current. It is indicated whenever the lesions are small or superficial. The most delicate effect can be obtained. I have destroyed individual dilated capillaries on the skin and have destroyed superficial lesions on the conjunctiva.

Therefore it should be used in all of the keratoses, fissures and warts. Amputation is probably better when the lesion extends

* Read at the Twenty-fifth Annual Meeting, AMERICAN ROENTGEN RAY SOCIETY, Swampscott, Mass., Sept. 3–6, 1924.

down to the bone. Electrical desiccation can be used whenever there is a layer of soft tissue between the lesion and the periosteum. If one destroys the periosteum, necrosis of the bone follows. Sometimes one can destroy the surface of the bone, and then remove the bone down to bleeding healthy bone and in this way avoid necrosis.

Both for theoretical reasons and from practical observation, I am convinced that it is a better method of treatment than excision. A wound from excision will heal sooner and with less discomfort, but the result will be less permanent, because the excision does not stimulate the development of new blood vessels.

FIG. 1*A*. Shows extensive keratosis and small epitheliomata following excessive chronic radiodermatitis. Photographed July 6, 1920. The patient had done roentgen-ray work with a static machine for nine years previously. Ninety-five lesions were destroyed under nitrous oxide gas.

FIG. 1*B*. Shows hand after all lesions had healed—July 15, 1921. Patient still has some few small atrophic areas.

Following the destruction by electrical desiccation or electrocoagulation, there is a violent reaction with sloughing and desquamation of the dead tissue. In small lesions this requires from two to four weeks. This reaction, however, seems to lead to the development of new capillary blood vessels and, as a result, better nourishment of the affected part. As a result, there follows a soft pliable, pink scar, which may not even be visible.

If the lesions are located on the posterior surface of a finger, where there is atrophy and fixation of the skin, and if the lesion is rather large, the healing may be slow, and insufficient blood vessels may have been formed. A second, central keratosis may therefore develop, and may require a second treatment. There may also be fixation of the tendons. Therefore, if the ulceration over a finger extends to the bone and all of the skin is atrophic, amputation will probably be preferable.

Fibrosis and secondary malignant degeneration may develop over areas that have been treated therapeutically with either unfiltered or filtered radiation. This degeneration may develop from two to ten years after radiation has ceased. If these lesions are located in areas that can be completely excised, and good healthy tissue exposed everywhere, then I believe excision is the shortest and easiest way out of the difficulty. This is usually possible when the abdominal wall is involved.

Frequently, however, complete excision is impossible, such as when the ulceration involves the neck, the chest wall or the face. Incomplete excision is dangerous especially if malignant degeneration has already taken place, and is likely to be unsuccessful, even if ulceration has not taken place, because no new blood vessels have developed, such as occurs after electrocoagulation. So, too, incomplete destruction by electrocoagulation will be unsuccessful, because of lack of nourishment.

Therefore, if the fibrotic area cannot be improved by massage, it is probably best to destroy the entire area by electrocoagulation, carrying the destruction into the healthy tissue. Surgeons who have been associated with me in the treatment of such cases are convinced that it is safer and better to destroy such areas, especially if they are malignant, than to depend upon excision.

Electrocoagulation consists of the coagulation of the tissue by means of a heavy Oudin current, with the needle plunged into the tissue and left in place until the tissue to be destroyed is turned white. be inserted directly into the tissue to be destroyed. In the latter case, the destruction will take place between the two electrodes.

Electrocoagulation was first described by me in 1914.[1] This method is applicable

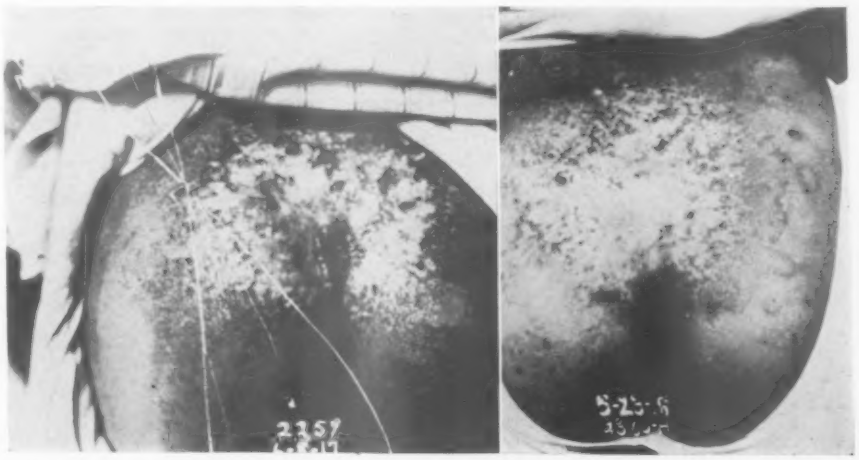

FIG. 2*A*. Patient had been treated for eczema in the hospital over a considerable period, and on June 8, 1917, reported because of the epitheliomatous degeneration in the area previously treated. Under general anesthesia this entire area was destroyed by electrocoagulation.
FIG. 2*B*. Shows this condition entirely healed and healthy one year later.

This effect can be partly intensified and any amount of tissue can be destroyed to any depth by the use of the d'Arsonval current in which use is made of two electrodes and a more intense current of lower voltage than the Oudin current. One of these electrodes may be a large pad applied to the back or buttocks, or two more or less pointed electrodes may where large areas or deep tissues are involved.

TECHNIQUE

Destruction by desiccation which is applicable to the small lesions is performed with the Oudin high frequency current. The smaller and more superficial the

FIG. 3*A*. Shows epithelioma in the fibrotic tissue which developed after radiation treatment, seven years previously. Patient treated by a caustic seventeen years previously.
FIG. 3*B*. Shows the same case eight months later, healed.

[1] Electrothermic coagulation and Röntgen therapy in the treatment of malignant disease. *Surg., Gynec. & Obst.*, 1914, xix. 783–790.

lesion, the smaller should be the needle and spark used. The exact size of spark and amount of current is a matter of judgment and skill. As an average, the use of a spark one-eighth of an inch long and perhaps one-sixteenth of an inch thick might be advised. Each lesion is then sparked until it turns white and becomes elevated by the serum beneath. I then curette away the crust or epithelioma. If the curettement shows bleeding or oozing the lesion is not completely destroyed, and if left in this condition a recurrence is likely to develop. It should be further desiccated until all granulation tissue is destroyed.

Following the destruction, there will be considerable exudate of serum, surrounded by redness and some swelling. If no dressing is applied, a crust will form and pus will collect underneath. This must be removed. A crust can be prevented from

Fig. 4*A*. July 13, 1917. Shows epitheliomatous degeneration nine years after operation for carcinoma of the breast, seven and a half years after radiation treatment. The remainder of the radiated area shows a leathery condition of the skin.

Fig. 4*B*. December 24, 1917. Shows the diseased areas after destruction by electrocoagulation healing very slowly.

Fig. 4*C*. November 1, 1918. Shows the areas which have been coagulated healed but new lesions have now appeared.

Fig. 4*D*. November 20, 1919. Shows the entire area after the slough had separated. The entire scar tissue had been destroyed by electrocoagulation on November 17, 1918, and at this stage is covered by healthy granulations; referred to Drs. DaCosta and Nassau for skin grafts.

Fig. 4*E*. February 7, 1922. Shows the entire area healed. It was practically in this same condition on January 23, 1920. Patient perfectly well to date, approximately sixteen years after carcinoma of the breast, and more than five years after malignant degeneration in the scar tissue.

forming by using a dressing with boric acid or zinc oxide ointment applied on a piece of lint or muslin.

In the case of extensive lesions on the hand, it is better if the hand be kept at rest on a splint. It may be bathed in normal salt solution or a mild antiseptic. If the lesions are small and scattered, they can be treated with local dressings or none at all. In the case of my own hands no dressings were applied on the dorsum. The fingers were placed in local bandages. At no time was I unable to work. In the case of some of my colleagues, however, the process was painful and they could not continue work.

The destruction of these lesions is painful. If they are few and scattered, each can be treated by local anesthesia and with 1 per cent novocaine. If many lesions are to be treated it is probably best to use nitrous oxide anesthesia or ether. *If ether is used it must have been completely removed before the time of destruction or an explosion will occur.*

For the destruction of large areas such as may follow in therapeutic cases in which there is an extensive fibrosis, a general anesthetic may be used. A heavy Oudin spark or usually the d'Arsonval is employed, and the tissue is destroyed down to and outward to healthy tissue. This will produce a heavy slough, and it may require two or three months for all of the necrotic tissue to be thrown off. At such time when healthy bleeding granulations have formed, skin grafts may be used or the lesion may be allowed to heal from the edges. I like to have the advice of a surgeon before deciding these questions.

During the destructive process, much can be accomplished by the use of the Carrel-Dakin solution, or one of the chlorine preparations to keep down the odor, and in the prevention of surrounding infection.

Tissue that has been irradiated heals more slowly than normal tissue. One should protect it as far as possible from traumatism and further infection. Sloughs and necrotic tissue should be removed as soon as possible. If the lesion has not been destroyed and healing does not take place, a second desiccation must be done.

This method of treatment, in my opinion, gives better results than anything else.

ABSTRACT OF DISCUSSION

Dr. C. A. Porter, of Boston, first discussed the treatment of keratoses. Since they are benign it is not of great importance how they are destroyed. He prefers to do it quickly and effectively by excision. If it recurs it is evidence that not all of the keratosis was excised. The vital point in deciding between destruction of a malignant lesion by simple excision or electrocoagulation is whether or not cancer cells are scattered by excision. Aside from this important question Dr. Porter believes that so far as comfort and speed of healing are concerned excision is far preferable to electrocoagulation.

Dr. C. G. Lane, Boston. I was interested in the fact that Dr. Pfahler spoke of the stimulation of new capillaries in the areas treated by electrocoagulation. It seems to me that this furnishes a definite means of getting nearer to normal skin. Dr. Pfahler also spoke of giving the patient a list of things not to use. I have been in the habit of doing the opposite, namely, of mentioning to patients the few things which they could use, such as boric acid solution, boric ointment or some other mild, soothing application. My experience with electrocoagulation in the treatment of superficial keratosis has been confined to small lesions which I have treated by the monopolar method, but I have usually treated these cases first with radium. We always have to remember, of course, that we are dealing with tissue already damaged by radiation and that we have to steer between the dosage which will produce a destruction of the lesion and one which is sufficient to produce an ulceration with long process of healing.

I believe that the plaques are preferable, usually unfiltered or at the most with only a very thin filter, perhaps 0.1 mm. aluminum; and we have to remember that in certain very superficial cases an erythema dose will usually be sufficient to clear up a lesion.

In this connection I have been interested in the last four years in watching the progress of certain roentgen radiation changes under the use of ultraviolet light with pressure. I refer particularly to the telangiectases occurring in radiated areas, and there are certain lessons which I have learned from the observation of these cases, which seem to me to be particularly applicable today.

I have watched particularly the case of a young school teacher who was radiated in 1912, 1913 and 1914, for tuberculous glands

and sinuses of the neck. She had an extensive area of scarring on each side of the neck and the upper part of the chest, with pigmentation and scars from an old tuberculous lesion. It seemed perfectly definite that the telangiectases themselves can be obliterated. This obliteration takes place best at the proliferation of a large lesion or in a small lesion; for instance, in the interstices of the neck of this young woman. At a distance of three or four feet the skin now looks nearly normal; the texture is very nearly normal, and close examination shows two or three telangiectases.

In this case I used at first only a minute's pressure, with a small applicator, and gradually increased the time to 2 minutes and 40 seconds at anywhere from 2 to 4 months' intervals, using only a few areas at a time; perhaps not more than four to six. At the later stages I produced a blister; at the earlier stages I did not.

Dr. Brown. What lens did you use?

Dr. Lane. The ordinary quartz lens.

The pigmented areas do not change under the quartz light pressure; in fact, some of them darken a little bit, so I should caution against the use of quartz light therapy in pigmented areas. I believe the same thing applies to the areas of scar tissue. In one case, over one of the scars there was rather slow healing, so that with the large, thickened scars, I should be inclined not to use the ultraviolet lamp.

In regard to the atrophy, that, in general, I think has remained much the same in the neck and the small areas treated. There is a definite improvement in texture of the skin. The skin feels much nearer normal instead of the dry feeling which it has had, and I am wondering whether the same thing does not occur in these cases as occurs in the cases Dr. Pfahler spoke of; that is, there is an increased stimulation to the production of normal capillaries in the area of intense reaction which surrounds the areas treated.

Another thing was the increased itching. There is a definite increase in itching, particularly in winter weather, after the use of the ultraviolet lamp. This, of course, is the result of trauma which has to be controlled in some way.

It is necessary also to look out for overdosage, as I said a minute ago. The overdosage can produce superficial ulcerations which are slow to heal, in fact so slow that it arouses a suspicion of malignant changes occurring. I believe that it would be perfectly possible for such changes to occur. I believe that it is best to proceed with an underdosage and to treat at intervals of four to eight weeks, with areas not too close together. It is advisable to give a slightly longer time and slightly more pressure to the peripheries of large areas than to small lesions. The larger vessels are not affected, and I doubt whether it is advisable to push the time or the pressure sufficiently to obliterate it. Finally, there is the value to the mental state of the patient; it does help, and while normal skin cannot be obtained, the method used with a good deal of caution affords relief in telangiectases occurring as sequelae to radiotherapy.

Dr. S. B. Wolbach, Boston. I would like to know if Dr. Pfahler has controlled any of his work by histological examination. Naturally, I am extremely interested to know what happens in these tissues, and it seems to me, if I may be pardoned for making the remark, that so much of that work can be controlled by animal experimentation; we can get more precise knowledge of what is happening, and it seems to me that roentgenologists, as a whole, are in a way somewhat remiss for not having developed among themselves pathologists or clinicians with the pathological training.

Professor Gösta Forssell, Stockholm. It is a very important question you have discussed here, and I must say that I agree with both the last speakers that malignant lesions following roentgen radiations are not to be treated with roentgen rays or radium; they must be treated with operation or electrocoagulation.

I have personally had only a very limited experience with these cases because I have seen only 5 cancers following roentgen treatment. I have never seen a case of malignant tumor following irradiation with radium.

Four years ago I gave a roentgen-ray treatment on a roentgen cancer and I regretted it very much. It was a case of a very big scar, following a roentgen ulcer on the back, and a big atrophy of the skin. In this atrophy occurred a cancer of the infiltrating type. I had not had any experience at that time with electrocoagulation, and I tried to treat it with roentgen rays. I limited the treatment to the area of the cancer. But after some time an ulceration appeared on the whole scar which became ulcerated, and the patient has had heavy pains. The cancer disappeared and has not reappeared in three years now, but the ulceration is still there. I have proposed to electrocoagulate it, but the patient does not agree to that.

In other cases we have treated with electrocoagulation with good results. At least in small cases the electrocoagulation method is very good and the scars are satisfactory.

With reference to idiosyncrasy, I am of the same opinion as Professor Porter, but there is

only one point I should like to emphasize, and that is that in the case of roentgen-ray damages I have seen, there have been several cases which had syphilis. I was consulted about a young boy who had an ulceration on the back of the knee. He had been successfully treated for an eczema which healed without any visible reaction, but six years later there appeared on the place of the treatment a deep ulceration. It was found that the father had lues; and probably the child had hereditary lues. In 3 other cases which showed late ulcerations after comparatively small doses, there has been lues in the history of the patients.

Now, before giving bigger doses, we always test for lues. I believe that that is necessary, to direct our observations on that point.

I believe we all know the best manner to avoid these lesions, and that is to measure our treatments exactly and in benign cases avoid doses causing an erythema, and not prolong treatment too much, even when using small doses.

Dr. J. D. Morgan, Philadelphia. I regret that I did not hear all of Dr. Pfahler's paper, but I heard enough to be able to say that our experience at the William L. Clark Hospital in Philadelphia confirms his opinion regarding the treatment of these conditions by electrocoagulation and desiccation. We have found that in addition to using the Dakin solution in the after-treatment, the use of physiological salt solution is valuable, and some cases that have refused to heal or been slow in doing so under the Dakin treatment, have cleared up comparatively rapidly when changed to the salt solution.

We find that skin grafting is rarely necessary except on very extensive cases, because it is remarkable how large an area of raw surface will cover over without the necessity of a skin graft. The treatment by electrocoagulation or desiccation seems to stimulate granulation to such an extent that an area that would not otherwise cover over does so in a startling manner after this treatment. The necessary point I think there is to make sure that all of the indurated edge is removed. Comparing the desiccation with coagulation, our experience has been that there is less tendency to recurrence after the desiccation than there is with the coagulation method. This is no doubt due to the greater difficulty in removing the whole of the disease by the knife. The coagulation effect extends to some considerable distance beyond the actual area treated, and with experience it is remarkable how accurately one can judge to what depth the heat effect will go, and even when working among arteries or other vital structures, you can, with sufficient experience, go ahead with considerable courage because the artery walls appear to be immune to anything except an excessive dose; due to the fact that the blood is constantly moving through, we have found the arterial walls very resistant to anything except excessive heat directly applied to them. I think that the danger of spreading these things by removing with a knife is lessened, therefore, by using the heat. Also the scar that is formed, particularly with the desiccation current, seems to be more elastic. This can readily be understood following the histological study; the scar tissue is directly dependent on the amount of destruction which has occurred before.

With the desiccation current it has been found histologically that there is practically no destruction of the cells at all; simply a dehydration, and with the coagulation the destruction of course is greater in proportion. It is quite possible for a pathologist who has had any experience, to tell immediately by examining a section whether a desiccation or coagulation has been used. With the desiccation, the cells are drawn out in threadlike manner and no destruction has occurred, whereas with the coagulation the cell outline is entirely lost and a myelinization appearance is shown and the blood vessels are thrombosed to some considerable distance below the surface.

Dr. Pfahler, closing. I appreciate all of this discussion and I know we might go on much longer. I think we should have learned by this time to be both fearful and careful. As you will see by the illustrations that I have shown and those that Dr. Porter has shown, these bad effects appear often a long time after we have done our work. Therefore, I don't think it is so much a matter of any rule that we can lay down as the rule of being cautious and studying this subject as thoroughly as possible. The more knowledge we have, and the more care we use, the less of these damaging effects we will have.

I agree with Dr. Porter that the primary thing with regard to these keratoses is to destroy them, but he has lost sight of the one point that I wanted to make, and that is that in my opinion—and I think it has been proven and I believe I can show it in my own hands—we increase the circulation after electrocoagulation, which is not done by surgery.

When we go to treating the larger lesions, if it is possible to excise them, that is the quickest, cleanest and easiest method, but when there is any doubt as to complete excision; that is, where you have to work on the chest wall,

where the cells may have gone down into the intercostal spaces or anywhere where there is any doubt of completely excising, then I believe we will accomplish better results by electrocoagulation. It is the longest, it is the most tedious, but I believe it is the best. I believe, too, that there is less likelihood of a recurrence, for the reason mentioned by Dr. Morgan, that we destroy the cells by the heat effect a little way beyond the actual destruction of our healthy tissue. However, that is a matter we cannot decide.

The other point I would wish for (brought up by Dr. Lane) is that some one who has sufficient skill and patience and opportunity will prepare a paper to teach us how to treat these telangiectases and the fibrosis that sometimes follow long continued treatment.

Also answering Dr. Wolbach with regard to animal experimentation, so far as I know we have not yet, except perhaps in Dr. Wood's laboratory, had any opportunity to keep animals long enough to develop these degenerating effects and then treat them and study them. That means a long time, perhaps five or ten years till we get through with it. But I think it ought to be done and I would like to see it done. Of course, there have been histological studies made following electrocoagulation, where tumors or tissues have been removed, but I know of no studies to show the condition of the tissues after treatment by electrocoagulation and healing.

THE RESULTS OF ROENTGEN THERAPY ON BRAIN TUMORS*

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I HAVE understood the term "brain tumors" in the usual sense of intracranial tumors which involve the brain in their growth. I am sure the time is past when it would be found profitable to discuss the radiotherapy of tumors of the *abdominal cavity*. It is just as useless to speak of the treatment of brain tumors *as a whole*, for in the intracranial cavity occur many types of tumors of various structure and each type reacts differently to roentgen rays. Flatau[2] has recently published such an imprecise discussion. The correct procedure we believe to be to separate as many pathologic entities as possible and discuss the reaction of each to radiotherapy.

Up to the present time 242 patients have received roentgen-ray treatment for brain tumor at the Peter Bent Brigham Hospital. Many of these have only begun their treatments there and have continued them in other clinics. However, 59 cases have been followed throughout their course in our clinic, and have received at least 6 treatments, which we consider sufficient to judge whether the treatment will be of benefit to them.

1. MENINGIOMA

The reaction of meningioma to roentgen radiation may well be illustrated by the following case:

On July 7, 1922, there was admitted to the Peter Bent Brigham Hospital (P. B. B. H. Surg. No. 17017) a Swedish housewife, aged fifty, with signs of intracranial tension and symptoms of a lesion in the left frontal lobe. Operation was refused until August 26, when a bone flap was turned down over the left frontal lobe. The brain, which was under considerable tension, was probed in various directions but no evidence of tumor could be found. Since we were unable to find the frontal horn of the lateral ventricle it was supposed that there was a subcortical glioma. The bone flap was removed and the skin incision sutured carefully. On September 13 she received roentgen-ray treatment over the operative field. She improved greatly (doubtless due to the decompres-

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sion) and was discharged on September 25. She had a series of roentgen treatments, but after the first two weeks there was no further improvement. She began to have epileptic attacks, more and more trouble with walking, became very stuporous and was readmitted to the hospital on July 17, 1923. On September 5 the old incision was re-opened and this time a flat tumor was found occupying a large part of the frontal and temporofrontal fossa. It was in large part removed, but the patient, whose condition was precarious before the operation, did not recover and died September 10. At necropsy it was found that the growth had been entirely removed with the exception of a small portion attached to the temporal bone at the outer end of the sphenoidal ridge. Histologic examination showed the tumor to be a typical meningioma. The cells showed no effect of the intensive radiation to which they had been subjected.

Here is a case where a typical meningioma had been thoroughly treated with roentgen radiation under a mistaken diagnosis; the tumor had undoubtedly continued to grow steadily under treatment, as is proven by the clinical evidence and by the fact that the tumor was not discovered at the first operation, when the brain was probed in the same manner. The outcome of this case is typical of what one may expect in any meningioma, and there is no reason to subject such tumors to roentgen therapy. They are the most susceptible of intracranial tumors to operative removal and they should be removed surgically whenever the diagnosis is made.

II. ACOUSTIC NEUROMA

Roentgen radiation has almost as little effect on acoustic neuroma as upon meningioma, as may be seen from the following history:

An Italian laborer, aged thirty-one, was admitted to the hospital January 18, 1916 (P. B. B. H. Surg. No. 4139) with signs of intracranial tension and symptoms of a lesion in the left cerebello-pontine angle. A suboccipital operation was done on March 3, and an acoustic neuroma partially removed. He improved rapidly after operation, but about one and a half years later began to complain of dizziness and vomiting. On July 15, 1919, he was readmitted to the hospital. As there were no pressure symptoms at this time he was discharged, but returned again August 30, 1920, complaining of headache, dizziness and difficulty in swallowing. Again no very definite signs of intracranial tension were discovered, so he was advised to have roentgen treatment, and from that time on he had a treatment every third or fourth week until April, 1921; then again from September, 1921 to November, 1922. During this time his condition changed practically not at all. The symptoms of a lesion in the cerebello-pontine angle, which had always remained quite marked, were not in any way influenced. The nausea and vomiting seemed to have been relieved to a certain extent until 1923, when even this good effect failed, according to the patient's account. He was readmitted to the hospital April 2, 1924. His neurological findings were identical with those found in August, 1920, when his roentgen treatments were begun. There were still no signs of intracranial tension. He was discharged feeling much better, although nothing had been done for him in the hospital.

It is very difficult to estimate the effect of the treatment on this patient. Certainly it had no influence on the neurologic findings. The temporary influence which it seemed to have on his nausea and general condition might very well have been a psychic effect, since these symptoms were not due to intracranial tension. It was very noticeable that admission to the hospital, although nothing was done for him, caused a very marked improvement in his general well-being. I think it is safe to say that in this case, as in all cases of acoustic neuroma, roentgen radiation offers little hope of amelioration.

III. PITUITARY TUMORS

There are two principal tumors arising from the pituitary body which by their growth involve the brain. These are (1) the suprasellar tumor arising from Rathke's pouch, which is almost invariably cystic, and (2) the adenoma of the anterior lobe of the pituitary gland.

(*a*) *Suprasellar Cyst.* We have never treated a suprasellar cyst with roentgen radiation, but there is no *a priori* reason to suppose that a cyst with a fibrosed and usually calcified wall would show any marked response to such treatment.

(*b*) *Pituitary Adenoma.* The adenoma of the hypophysis, on the contrary, sometimes reacts very favorably to roentgen treatment. It may be illustrated by the following case:

There was admitted to the hospital on May 25, 1920, a Jewish housewife, aged thirty-seven (P. B. B. H. Surg. No. 12494) with failing vision and signs of a tumor of the pituitary body. On July 1, 1920, an adenoma was partially removed by the transphenoidal route. She had one roentgen treatment before discharge from the hospital, but the treatments were not pursued. On October 3, 1921, she was readmitted to the hospital with symptoms of a recurrence of the tumor. On November 5, 1921, a transfrontal operation was performed and a portion of the adenoma bulging between the optic nerves was removed. She was discharged on February 6, 1922, and since this time roentgen treatments have been steadily continued, with definite improvement in vision following these treatments, and failure of vision during intervals of non-treatment, as shown by repeated examinations of the visual fields. At the time of the last examination, August 16, 1923, she had 20/40 vision in the right eye as compared with 20/200 two weeks after the operation. There had never been any central vision in the left eye, but the nasal field remains practically constant.

It would seem, not only from this case but from repeated experience, that considerable improvement can be obtained in cases of pituitary adenoma by means of roentgen radiation. Although our results are perhaps not so favorable as those published by Béclère,[1] nevertheless roentgen treatment should be tried if the patient is not in imminent danger of losing his eyesight, provided the visual fields can be followed carefully and the patient operated upon if vision continues to fail. Certainly after operation continued treatment should be given. The treatments are not entirely without danger, for there have been in several instances headaches and nausea following 24–48 hours later. For example, D. C., T. 827, a patient with acromegaly, suffered from headaches and nausea twenty-four hours after treatment. E. M., T. 805, had a severe headache with vomiting and marked diminution of vision. These symptoms suddenly ceased and a subsequent operation showed that the tumor had decompressed itself by rupturing into the sphenoidal sinus. It does not always do this, however. C. C., T. 631, an acromegalic with a pituitary adenoma, had had marked improvement in strength and general vigor and decrease in headaches following roentgen treatments until finally, a few hours following a treatment, there was a rapidly developing and marked loss of vision which persisted until a transphenoidal operation was done with partial removal of the edematous and necrotic gland.

TECHNIQUE OF TREATMENT

At this clinic roentgen-ray treatments for pituitary adenomata are given at intervals of three weeks. The rays are directed to the pituitary fossa through 3 portals of entry. Areas 3½ inches square over the temporal bone on each side and, occasionally, a similar frontal area are used for this purpose.

The treatments consist in a maximum skin dose at each sitting, and are composed of approximately the following factors for the ordinary 10- or 12-inch roentgen-ray machine: 9 to 10 in. spark gap (80,000 to 100,000 v.), 12-in. target skin distance, 5 ma. for 30 min., filtered through 0.25 Cu and one thickness of sole leather.

This dose usually causes an epilation of the areas treated, but rarely causes an erythema. Treatment through one area is not repeated at an interval of less than three weeks. The treatments may be combined with radium therapy, the radium being placed in the sphenoid sinuses. Theoretically this combined treatment would seem to be ideal. Practically, in our experience, it offers no advantage over straight roentgen therapy. If the condition of the patient's vision permits and a surgeon is not at hand capable of dealing

with the possible complications it might be well to begin with doses smaller than those we have just outlined.

IV. GLIOMATA

About 40 per cent of tumors of the intracranial cavity develop from the brain substance itself, and these are almost invariably of the type called "gliomata." Such tumors react very irregularly to roentgen treatment. For example, the following 2 cases are quite similar so far as location and gross appearance of the tumor are concerned:

(1) A contractor, aged forty-eight, was admitted to the hospital November 8, 1922 (P. B. B. H. Surg. No. 17782) with signs of intracranial tension and symptoms of a lesion of the right frontal lobe. On November 13, 1922, a bone flap was turned down disclosing an extensive tumor of the substance of the right frontal lobe. Since it was impossible to remove it, the bone flap was taken off and the scalp incision carefully closed. Roentgen treatment was started at once and continued vigorously, but the patient gradually failed and died on May 9, 1923, seven months after operation. Necropsy showed a very extensive tumor of the right frontal lobe.

(2) An English housewife, aged thirty-three, was admitted to the hospital November 15, 1923 (P. B. B. H. Surg. No. 2125) with signs of intracranial tension and symptoms of a lesion of the right frontal lobe. On November 28, a bone flap was turned down and an extensive tumor of the right frontal lobe was disclosed. It was impossible to remove the tumor, so the bone was taken off and the skin sutured carefully. Roentgen treatment was started at once and continued vigorously. At the present time the patient is very well. The decompressed area over the tumor, which bulged markedly at discharge, has sunken in so that it is now concave. Her epileptic attacks have ceased and she is doing her housework, complaining only of slight dizzy spells.

The contrast between these two cases could hardly be more marked, yet in each instance there was a tumor of the brain substance involving extensively the right frontal lobe. If we consider tumors of the cerebellum we shall find a very similar situation.

(3) A boy of ten was admitted to the hospital January 6, 1923 (P. B. B. H. Surg. No. 18049) with signs of intracranial tension and symptoms of a central cerebellar lesion. The incoordination of his extremities was so great that he was unable to stand or feed himself. On January 17, 1923, a suboccipital exploration was done, disclosing a grayish-red tumor occupying the cerebellum between the hemispheres. No attempt was made to remove it. Active roentgen therapy was given. By May 23, 1923, he could walk with scarcely any incoordination. Symptoms of intracranial tension have entirely disappeared, and except for occasionally vomiting his breakfast he is still well.

(4) A little girl, aged three and a half, was admitted to the hospital May 12, 1920 (P. B. B. H. Surg. No. 12416) with signs of intracranial tension and symptoms of a central cerebellar lesion. On May 21, 1920, a suboccipital exploration was done, disclosing a grayish-red tumor-mass projecting between the hemispheres of the cerebellum, a large portion of which was removed. Roentgen treatments were begun at once, and continued vigorously, but although there was temporary improvement in her general condition she soon began to fail and died September 28, 1920.

Here again, as in the case of the frontal lobe tumors, were two tumors of the brain substance identical in location and in general appearance. In the last patient a large portion of the tumor was removed and apparently she should have had a better chance to recover. On the contrary, she steadily failed under treatment and finally died.

Can it be that the difference of reaction is due to some difference in histologic structure, and can we predict from the histologic structure of the tumor how it will react to the roentgen ray? That is a question which we are trying to answer at the Peter Bent Brigham Hospital, but the study is not complete, and it would be premature to announce our results at the present time. Roentgenologists are familiar

with other examples of this different reaction of apparently anatomically similar tumors to identical roentgen treatment.

However questionable the results may be in certain instances, much can be accomplished at times even with the most unfavorable cases. For example, the following history is given:

A man, aged twenty-three, was admitted to the hospital April 23, 1923 (P. B. B. H. Surg. No. 18688) with signs of intracranial tension and symptoms of a lesion in the mid-brain, most probably a glioma. On May 5, 1923, a decompression was done which did not influence his signs of intracranial tension. Roentgen treatment was then started with very marked effect. His tension symptoms disappeared and he was allowed to go home. Since that time he has continued roentgen therapy with the very definite result that during a series of treatments his choked discs subside, his headaches disappear and the decompressed area becomes soft. If he is left for a couple of months without treatment the decompressed area becomes tense, the headaches reappear and his discs become choked. Although the nature of the lesion is unknown, the effect of roentgen radiation is unquestionably good on an otherwise hopeless condition.

The technique which is used by Dr. Sosman for such treatments in this clinic is as follows:

TREATMENT TECHNIQUE

This is the average technique in general use, except that we use copper filters instead of aluminum, as Duane has shown that, for a given quantity coming through the filter, the copper allows a greater percentage of the shorter or more penetrating rays to pass. Aside from this —0.25 mm. Cu—we use an ordinary "10-in. machine," running at approximately 100,000 v., a 12-in. target distance, and give on the average 150 ma-min. This causes epilation in nearly all cases, but erythema in only a few, and that only to a slight degree.

In surface tumors, or the more superficial ones, a single portal of entry for the rays is used, while in gliomas of the corpus callosum, pons, or other deep or mid-line tumors we usually cross-fire from both sides. This latter procedure is often of value in cerebellar cases. The immediate reaction in these cases is not often severe, and may be of value in prognosis. Those who have the most reaction seem in the end to respond to therapy better than those without reactions. Treatments are given at intervals of three weeks, usually 6 or 8 in number, followed by a series of 3 or 4 treatments after several months have elapsed, or in case there is a recurrence of symptoms.

INDICATIONS FOR TREATMENT

It seems to us to be a fundamental axiom of scientific medicine that any therapeutic procedure must be based on a clear knowledge of the pathologic lesion to be treated. Therefore, before undertaking the treatment of a case of brain tumor by means of roentgen radiation, one should be certain at least of the location of the tumor and of its microscopic structure. At the present time one is able to make a localizing diagnosis in an ever-increasing number of brain tumors. It would be desirable to make also a pathologic diagnosis, but this is not so easily done. In the case of the meningioma it is possible, however, by means of the roentgen ray alone, to make a positive diagnosis in approximately 50 per cent.[3] Of the tumors of the pituitary body, it is possible to make a positive pathologic diagnosis by means of the roentgen ray in about 85 per cent of the tumors of Rathke's pouch.[4] A positive diagnosis of tumor of the acoustic nerve may also be made from the clinical examination alone in over 90 per cent of the cases. It is not, however, so easy to make a positive diagnosis of glioma previous to the operation, and this diagnosis must be made almost always by exploration.

A localizing diagnosis is necessary for operation; a localizing and pathologic diagnosis is necessary for roentgen treatment. Since in a large percentage of cases a pathologic diagnosis cannot be made without operation, an exploration should always precede roentgen therapy with possibly the one exception indicated above of adenomata of the pituitary gland. If the progress of the tumor can be followed

by repeated visual field examinations, an adenoma of the hypophysis may be treated before operation. The diagnosis of meningioma, acoustic neuroma or tumor of Rathke's pouch may be positively established previous to operation in the percentage of cases noted above, but these tumors are not favorable for roentgen treatment.

An operation, therefore, is a necessary preliminary to roentgen therapy, except in cases of certain pituitary adenomata, if one wishes to avoid such occurrences as Flatau records in his series of brain tumors treated indiscriminately without histologic verification.

Whenever a tumor of the brain substance is found which cannot be removed, or is removed only in part, it should be subjected to as intense roentgen treatment as is compatible with the well-being of the surrounding brain tissue, even though we know that the effort to destroy the tumor or to prevent its recurrence will in some cases be futile.

SUMMARY

Roentgen therapy of intracranial tumors should not be undertaken blindly, but should wait upon as accurate localizing and pathologic diagnosis as it is possible to make, even though operation may be necessary to establish it.

Roentgen therapy offers little hope of amelioration in cases of meningioma, acoustic neuroma, and tumors of Rathke's pouch. Pituitary adenomas respond well to roentgen-ray treatment, but this treatment is not altogether without danger, and the visual fields should be carefully followed while treatment is in progress. Tumors of the brain substance, usually called "gliomata," sometimes are very much improved by roentgen therapy and sometimes do not respond at all; the reasons for this variability are not well understood, but every such tumor should be subjected to treatment (after an attempt has been made to remove it, where this attempt is thought advisable) and often good results may be obtained in apparently hopeless cases.

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IMMEDIATE METABOLIC DISTURBANCES FOLLOWING DEEP ROENTGEN-RAY THERAPY

A PRELIMINARY REPORT OF AN EXPERIMENTAL AND CLINICAL STUDY*

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THE recent contributions of Schmitz[1] and of Rolleston[2] review the present knowledge and emphasize the importance of this field in such a comprehensive manner that a similar review here would be out of place. These reviews demonstrate the number and variety of contradictory conclusions concerning the reaction of the organism to radiation therapy.

The trend of present work is perhaps best expressed in the conclusions of Pendergrass, Hayman, Houser and Rambo,[3] "The effect of radium is due to a two-fold action; first an effect upon the nucleus and cytoplasm of the cell which causes, secondly, the death of the cell under conditions favoring autolysis." Colwell and Russ[4] in their recent book feel that no general theory as to the effect of radiation can be formulated but impress the reader with the disturbance of the colloidal equilibrium of the cell produced by radiation which might decrease its resistance to intracellular enzymes.

As early as 1903 Bohn[5] expressed the view that radium acts chiefly on the nucleus of the cell, either increasing its activity or causing its death.

Heile,[6] in 1904, in studying the urinary constituents after radiation found an increase in uric acid and purines, making the deduction that increased autolysis of nucleo-proteins explained these increases.

Edsall and Pemberton[7] in 1907 suggested that the intoxication was due to cellular destruction occurring chiefly in tissues rich in nucleo-proteins, and that the products of this form of protein are toxic, difficult to metabolize and to excrete.

More recently Hall and Whipple,[8] working on dogs, demonstrated a marked increase in the urinary nitrogen, purines and phosphates.

In 1922 Hussey,[9] investigating the theory of acidosis in radiation sickness, showed that there resulted rather an uncompensated alkali excess and that this is paralleled by decrease in the leucocytes. Finding the same changes following the intraperitoneal injection of sodium bicarbonate, he suggested that there is a relationship between the effect of salt and the effect of roentgen rays.

Anderson and Kohlmann,[10] after finding the potassium and sodium decreased, and the calcium content of the blood slightly increased, conclude that radiation sickness is due to vagus stimulation brought about by sodium being attracted to the cells.

After the repetition of some of the work of other observers it occurred to us that the theories of acute nuclear destruction and salt action as causing the immediate metabolic disturbances might be altogether compatible, especially if some constituent of the nuclei could be demonstrated in the blood coincident with the nausea and vomiting often seen during treatment or within a one hour period. Further, through the same nuclear destruction strong bases could be evolved producing alkalosis and more generalized cellular death through salt action.

The first postulate is supported by the demonstration of immediate large increases in organic phosphorus in the blood of both patients and dogs.

The second postulate is supported by primary short decreases with later increases in inorganic phosphorus, alkalosis, increase in uric acid, the presence of guanidine and the protective action of morphine, ether and calcium salts.

METHODS

For determination of non-protein nitrogen, sugar, uric acid and amino acids the well-known methods of Folin[11] have been used.

In estimating the different kinds of phosphorus, we used the technique

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described by Benedict.[12] Inorganic phosphorus has been determined on plasma, hydrolysable, acid soluble and lipoid phosphorus on whole blood. For calcium the method of Clark[13] has been adopted.

To determine the carbon dioxide content of the blood we used Van Slyke's[14] gasometric method and for determination of the hydrogen ion concentration of blood plasma we used Myers[15] colorimetric method.

The radiation has all been carried out with a modern deep therapy installation in which neither the tube nor any part of the high tension apparatus was in the same room with the subject. An efficient suction ventilator also exhausts both the tube room and the treatment room so that the question of ozone producing any part of the sickness is definitely eliminated. There is a grounded metal fieled between the patient and the high tension parts, thus eliminating any static field around the patient. The tubes used have been the standard deep therapy tube and the new water cooled tube. The voltage employed has been constantly 200,000. The milliamperage has varied from 4 to 30. The filters have varied from 0.25 mm. copper to 1 mm. copper plus 1 mm. aluminum. The skin target distance has been 50 cm. Our depth dosage has been calculated on the basis of the human erythema dose by carefully checked up depth dosage charts.

WITH TUMOR MASS

Name	Clin. Diag.	Part Treated	Size Tumor in Cm.	Dosage in Ma. Min.	Reaction	Phosphorus I.P.	Phosphorus H.P.	Phosphorus Ac.S.P.	Uric Acid	Amino Acids	NPN	Ca.	Sugar
G. H. 44121	Ca. neck	Neck	8 × 8	360	None	....	11.52 12.33	27.8 28.1	6.67 7.27	7.0 6.36	36.1 33.3		
E. M. 17991	Ca. breast recurrent	Chest	1 × 1	4 days tr. 300 to 420	Nausea, sl. vomiting stopped by Ca by mouth	4.08 4.14 4.33 after several tr.	.....	32.28 ..... 36.08	....	....	....	8.6 8.25 8.7	
E. S. 44813	Ca. breast pre-oper.	Chest Axilla Neck	5 × 5	320 560 440	Nausea, vomiting 8 hrs. later. Ca. stops vomiting	....	16.38 16.20	36.8 38.9	3.77 3.64	7.14 6.79	29.1 28.2		
W. R. 41809	Ca stomach	Abdomen	Antrum stomach	450	Vomiting 10 min. after tr. nausea III. Successful ca. therapy.		11.4 14.1 3 hours after treatment	27.18 31.23	2.05 2.10	6.17 5.90	28.0 28.2	8.8 8.6	82.0 91.0
				300 300 300	Nausea II. No vomiting. Nausea II. No vomiting. Nausea II. No vomiting								
E. D. 41791	Ca. jejunum	Abdomen	10 × 10 est.	360 360 160 240	Sl. nauseated 0 0 0		13.59 14.67	25.02 26.79	2.56 2.63	6.06 5.38	33.2 37.4	8.2 8.2	73.0 82.7
J. C. 30166	Ca. cervix recurrent	Pelvis	1 × 1	Radium 380 380 380 380	Nausea I Nausea I 0 0 0		14.07 14.10 after radium 13.11 after x-ray	26.79 24.03 24.39	2.68 2.67 2.58	6.16 5.69 6.05	29.5 26.5 36.9	10.5 9.5 9.3	109.9 103.1 83.5
O. C. 34092	Pre-oper. Ca. stomach	Abdomen	Antrum stomach	320 320 360 400	10 min. after tr. nausea II. Chills, fever. No. tr. 2 days later 0 0 Nausea, vomiting.		11.94 12.63 First treatment	25.35 28.83	2.09 3.30	6.89 5.83	50.8 50.0	10.0 9.5	81.0 95.2
I. S. 45340	Ca. stomach	Abdomen		320 400 360 240	Immediately after nausea II. Relieved by Ca		10.20 10.89 First treatment 10.41 Third treatment	30.24 32.10 29.34	4.65 4.65 5.70	7.48 6.28 6.52	34.5 34.9		108.6 109.9 140.8
E. S. 42823	Ca. sigmoid met. to liver	Pelvis Abdomen		440 440 360 340 240		4.96 5.00	9.27 15.30	22.86 46.06	5.69 5.98	9.33 6.36	63.05 50.0	10.6 9.9	98.5 123.5

WITH TUMOR MASS—*Continued*

Name	Clin. Diag.	Part Treated	Size Tumor in Cm.	Dosage in Ma. Min.	Reaction	Phosphorus I.P	Phosphorus H.P.	Phosphorus ASP.	Uric Acid	Amino Acids	NPN	CA.	Sugar
H. B. 7827	Ca. cervix	Pelvis	Small mass in pelvis	440 440 440	Very sick after sev. treatments. No tr.	4.46 4.46	9.80 10.83	30.6 38.34	3.78 3.89	6.9 6.3			
M. S. 44576	Ca. cervix	Pelvis	Massive growth	490 450 450 450	Nausea II. Vomited sev. times. Intravenous Ca with good results		10.71 13.20 ½ hr. after third treatment	35.1 39.6	2.88 3.36	6.55 6.58	25.0 26.1		
A.W. 43406	Ca. cervix	Pelvis	Large growth	594	Vomiting. Nausea III. Rel. by intravenous Ca		12.55 12.45 4 hours after treatment	29.34 29.79	2.18 2.10	5.93 5.80	34.5 35.3	8.2 7.9	88.5 93.2
				300 148 228 108	Nausea I 0 0 0								
H. B. 45391	Carc. bladder	Pelvis	Large tumor	400 200 200	Nausea I 0 0		14.22 15.12 3 hrs. after third treatment	28.83 30.24	3.45 4.91	7.10 6.75	37.0 60.0		
V. W. 14570	Ca. cervix recurrent	Pelvis	Large growth	440 440 440 440	Nausea II 0 0 0		10.77 11.09 After treatment	31.38 32.28	3.74 5.41	6.54 6.06	25.0 27.0		
J. K. 47451	Ca. face	Neck	6×4	360 360	0	3.47 3.98 1 hr. after first treatment	15.00 16.92	34.08 38.34	3.91 4.37		29.7 40.0	11.00 11.00	
						4.12 5 hrs. after first treatment	17.91	40.74	5.03		33.7	11.05	
							18.00 2:30 p.m. next day	32.58	3.28		37.2	11.00	
B. C. 44912	Ca. cervix	Pelvis	2×3 est.	360 360 360 360	0			33.32 37.53	2.82 2.82		27.4 24.1		88.7 87.4

WITHOUT TUMOR MASS

Name	Clin. Diag.	Part Treated	Size Tumor in Cm.	Dosage in Ma. Min.	Reaction	Phosphorus I.P.	Phosphorus H.P.	Phosphorus Ac.S.P.	Uric Acid	Amino Acids	NPN	CA.	Sugar
M. S. 45667	Ca. breast post-oper.	Chest Neck Axilla	0	360 380 360	None		12.51 13.38 1 hr. after treatment	33.32 34.11					
							14.10 5½ hrs. after treatment	34.24					
J. S. 2588	Ca.	Neck	0	360			13.05	38.34	2.31	7.14	33.3		80.7
				360			12.33 Sec. spec. after second treatment	40.74	2.38	7.68	33.0		62.5
D. B. 21996	Ca. both breasts Post-oper.	Neck Chest	0	360 360 360 468 468	Sl. nausea once or twice. Relieved by Ca		12.50 13.87	25.56 32.1	3.01 2.92		22.7 24.5	9.5 8.85	72.7 69.5
A. M. 12093	Ca. breast post-oper.	L. chest L. neck	0	360 360 360	Sl. nauseated. No vomiting		9.60 11.49 After third treatment	17.85 23.43	2.65 2.11	8.33 6.50	40.0 25.7	8.7 8.6	104.2 86.2
G. S. 40231	Ca. cervix	Pelvis	No recurrence	420 420 420 420 420 420	Considerable nausea. Vomiting	6.14 6.24 3 hours after second treatment	11.94 14.10	23.4 28.6	4.00		25.0 38.0		
						6.86	15.10	27.4	5.20		35.2		
H. C. 37441	Ca. rectum	Pelvis	No recurrence		Very nauseated. Vomited after each treatment	6.04 6.05	12.5 12.8	25.4 33.8	2.29 2.36		20.7 25.9		
M. B. 41176	Ca. cervix	Pelvis	No recurrence	380 380 380 380	Nauseated each day. No vomiting. Chill and fever		13.2 11.52	36.6 38.4	2.49 1.78	6.93 6.93	29.7 33.0		85.2 101.5

Observation on Patients. The studies on 23 patients charted above bring out the increase in acid soluble phosphorus occurring early, coincident with the nausea, vomiting and alkalosis. Within a few hours increases in inorganic and hydrolysable phosphorus, an increase in uric acid and decrease in amino acids take place. These changes are variable but for the most part entirely consistent, and exaggerated in some cases having large tumor masses. This holds whether the tumor be in the pelvis, abdomen or neck, but the most remarkable changes were seen in the cases with large abdominal tumors irradiated with the water cooled tube. The results vary according to the time of blood withdrawal in relation to the treatment. More frequent and more complete analyses were desirable in many instances, but few patients were willing to cooperate completely.

These studies were supplemented by work on dogs radiated over the abdomen with very large doses to accentuate the metabolic changes.

1. *Phospborus of Blood.* The distinct changes in phosphorus were not so striking on the patients as they were on dogs, especially those animals with large doses. As shown in the charts, where lethal doses with the water cooled tube were administered, transitory increases in the acid soluble phosphorus of 100 per cent is coincident with severe nausea and vomiting. During this rise in acid soluble phosphorus there is a fall in the hydrolysable and especially inorganic phosphorus followed by distinct increases.

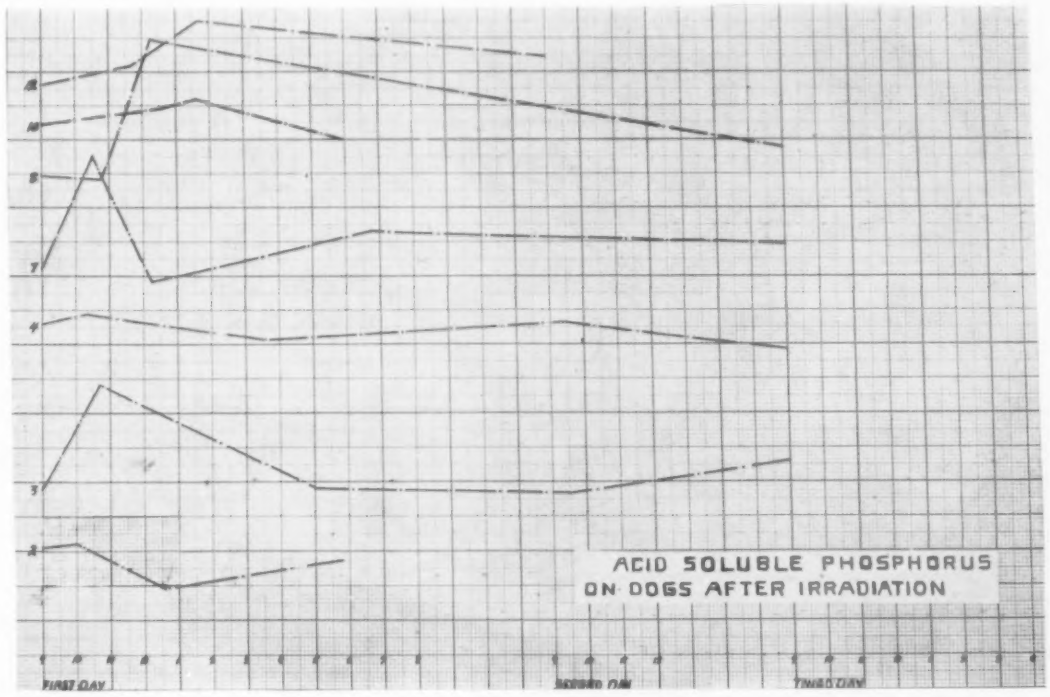

CHART 1. Total acid soluble phosphorus; shows marked initial increase in animals receiving lethal doses, especially animals 7 and 8.

2. *Acid Base Balance.* We were able to confirm the work of Hussey[9] as to the hydrogen ion concentration in dogs as well as in patients but found no distinct change in the CO_2 combining power of the blood corresponding with the work of Golden.[16] As shown in the charts, the alkalosis begins very early and lasts for varying periods depending upon the dosage and tissue irradiated. In very large or lethal doses the alkalosis persists for days or until death occurs. With smaller dosage the pH returns to normal within the 24-

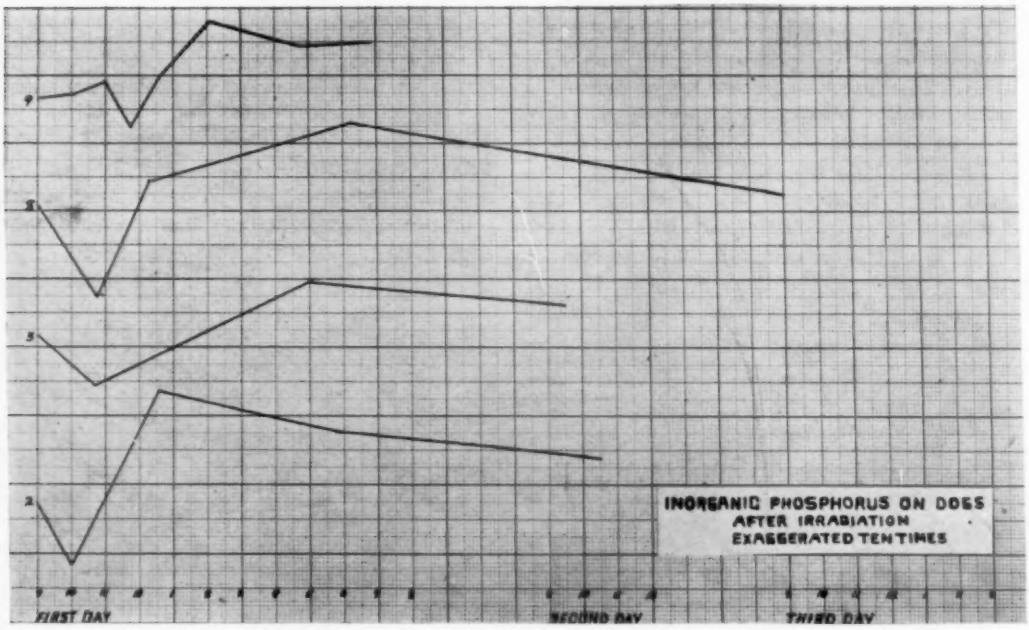

CHART 2. Inorganic phosphorus; shows marked initial decrease within few hours after treatment.

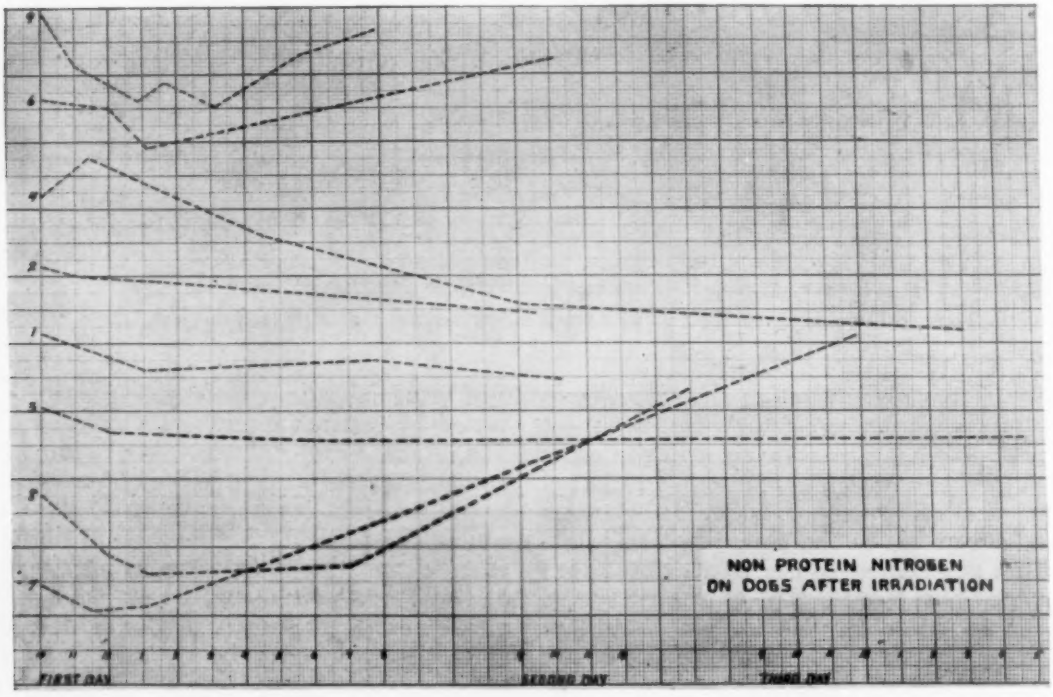

CHART 3. Non-protein nitrogen; shows initial decrease with later increase, especially in dogs 6, 7 and 8 which received lethal doses.

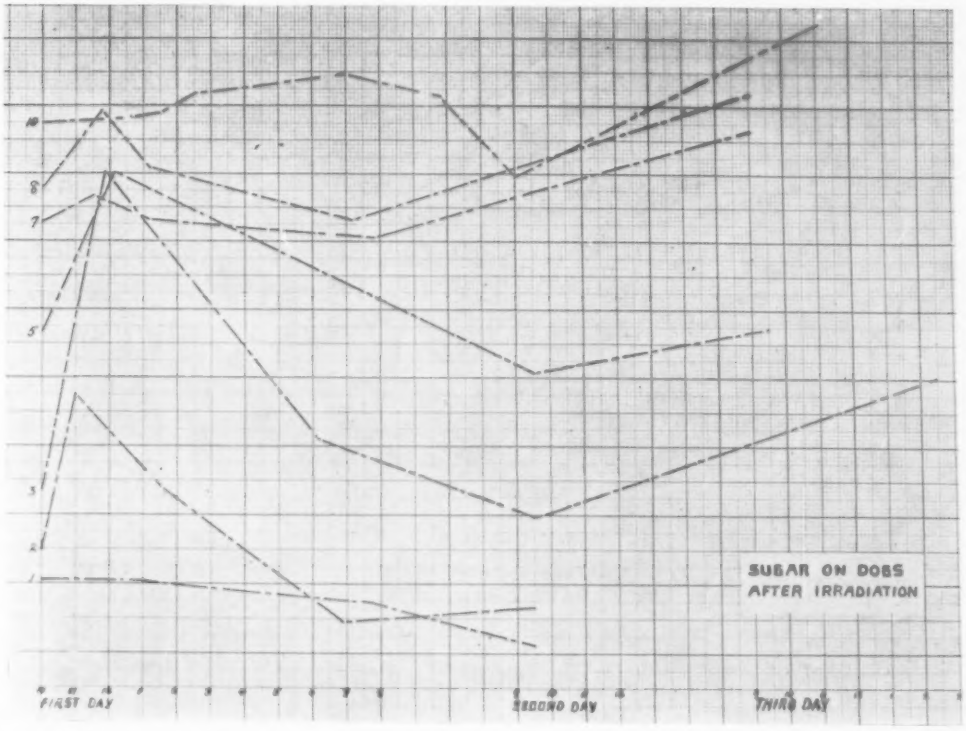

CHART 4. Blood sugar; initial increase exaggerated in dogs 2, 3 and 5 by anesthetics. There is distinct hypoglycemia after this initial increase.

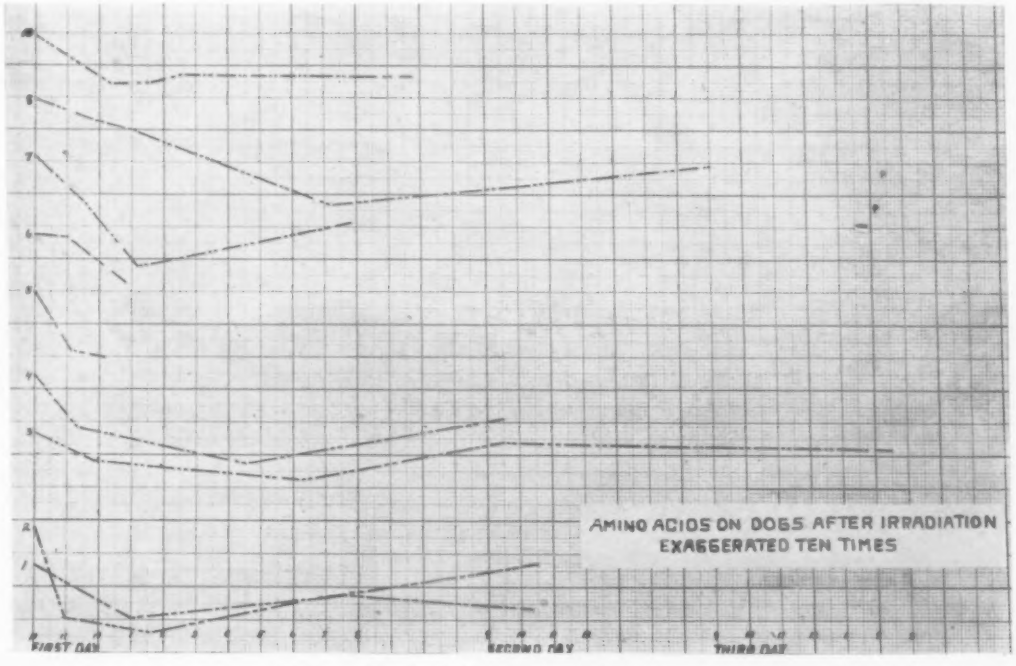

CHART 5. Amino acids; initial decrease with gradual return to normal.

hour period and is over compensated. This over compensation in the case of patients we believe often prevents acute symptoms after the second and subsequent treatments.

4. *Amino Acids.* Amino acids of the blood were investigated because they are decomposition products of protein; we believed they should be increased if there

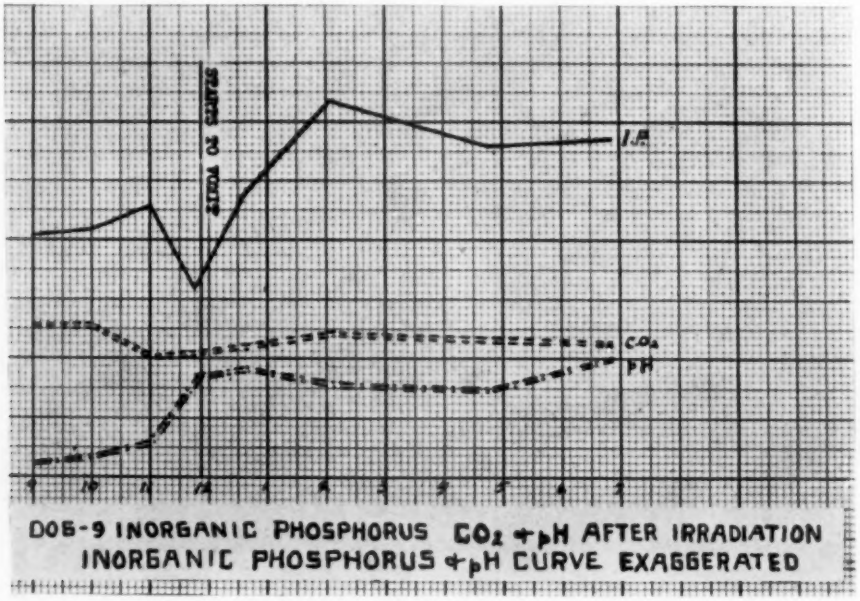

CHART 6. Inorganic phosphorus, CO_2 and pH; the onset of vomiting is coincident with an elevation in the pH and a depression in the inorganic phosphorus. The CO_2 shows only slight deviation from normal.

3. *Sugar Content of Blood.* In dogs there is a consistent and immediate rise in the sugar curve, with fall and secondary rise on the third day. These increases are greatly exaggerated by the influence of morphine and ether. The initial rise we feel may arise from hexoses of destroyed nuclei and deamidation of amino acids by increased enzymic action.

was sudden destruction of large numbers of cells *in toto*. The marked decreases noted suggest that the protoplasm of the irradiated cells remains intact during the early stages and further that there is an increase of enzymic activity producing deamidation with resultant increases in sugar content.

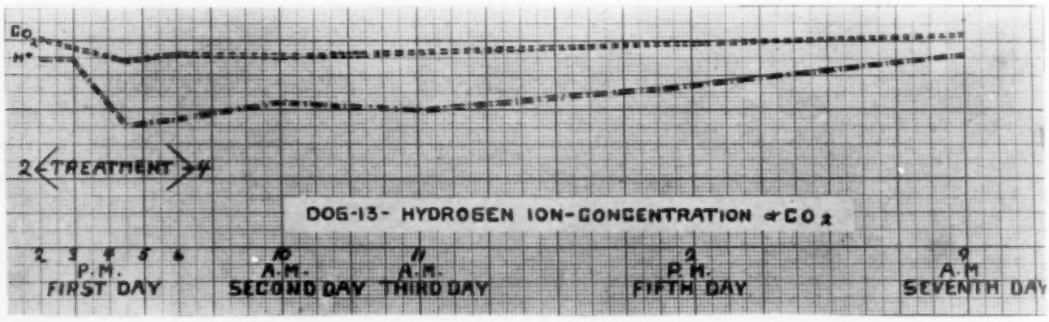

CHART 7. Hydrogen ion concentration and CO_2; there is an initial depression of the hydrogen ion concentration with slow recovery along with general improvement in condition of the animal. CO_2, as in Chart 6, shows only slight deviation from normal.

5. *Non-protein Nitrogen.* Numerous workers have noted increased non-protein

nitrogen in the blood but these changes come 18 hours to several days after radiation. Dodds and Webster[17] show distinct decreases in the urea of the blood. Our animals show marked decreases in the non-protein nitrogen during the first hours with later increases of from 75–100 mgm. per 100 c.c. in those receiving near lethal or lethal doses. In only a few instances did the dogs show increases in non-protein nitrogen sufficient to justify the term "acute uremia" suggested by Anderson and Kohlmann.[10]

have been demonstrated both on patients and dogs, especially patients with large tumor masses and dogs receiving lethal doses. At the same time we get distinct decreases in amino acids and non-protein nitrogen, furthering the belief that only the nucleus is destroyed in this early period. Only those animals receiving morphine and ether had a latent period similar to that described by Hall and Whipple;[8] however, these animals showed characteristic changes in the phosphorus content of the blood. This led us to believe that

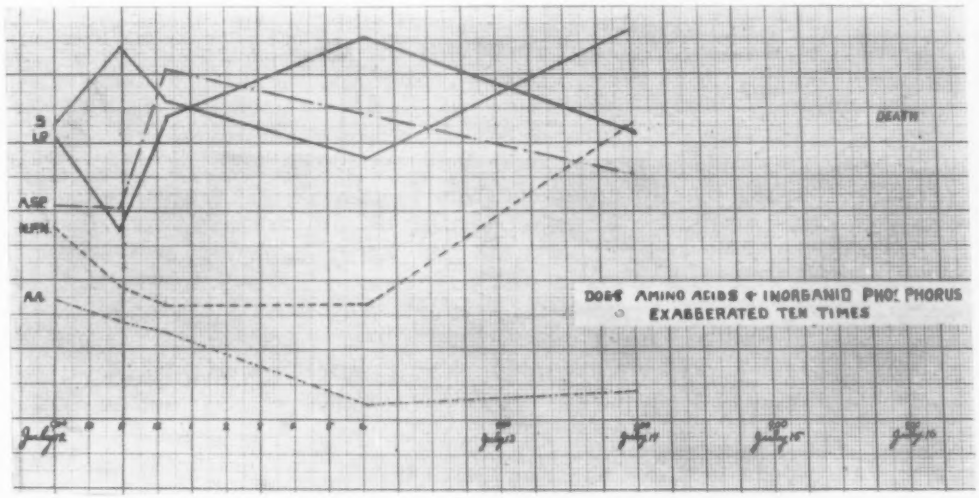

CHART 8. Chart of S-sugar, I.P.-inorganic phosphorus, A.S.P.-acid soluble phosphorus, N.P.N.-non-protein nitrogen and A.A.-amino acids in an animal receiving a lethal dose. These curves on the same animal bring out the same points shown in Charts 1, 2, 3, 4 and 5.

6. *Calcium of Blood.* Attention has been called to decreases in sodium and potassium. Calcium has been emphasized as showing slight increases and used as a therapeutic agent by Anderson and Kohlmann,[10] Dodds and Webster.[17] Our results show a slight depreciation in the calcium content, but this seems of a secondary nature and possibly due to the sweeping out with the large increases in phosphorus. Anderson and Kohlmann[10] reported a maximum increase of 0.6 mgm. per 100 c.c. while some of our experiments show decreases up to 1 mgm. per 100 c.c.

DISCUSSION

Immediate large increases in the phosphorus content of the blood have been taken as an index of acute nuclear destruction following radiation. These changes

there was some definite protective action due to these substances. As cited by Clowes,[18] anesthetics reduce the permeability of both emulsion systems and protoplasm to water. Further, it is a well-known fact that both morphine and anesthetics tend to increase the sugar content of the blood and to diminish the alkali reserve. The combination of these influences, we believe, protects the organism from the immediate effects of radiation.

Along with the phosphorus thrown into the blood by nuclear destruction there are certain other products of nucleic acid origin chiefly uric acid and a number of purines with basic properties. Uric acid has been found by various observers definitely increased in both blood and urine. The purines are reported increased in the urine. As shown in the charts we find increases

in uric acid in the blood. In an attempt to determine the excess of purine bases and their decomposition products in the blood one dog which had received a lethal dose was exsanguinated on the fourth day.

Following the methods of Sharpe and Williams,[19] 350 c.c. of blood from this dog was transferred to methyl alcohol precipitating most of the proteins. The remainder of the protein was precipitated by lead acetate. The excess lead was removed by hydrogen sulphide. This gave, after treatment with platinic chloride, a filtrate from which 30 mgm. of gold chloride guanidine was obtained and further identified as guanidine picrate.

Since the blood contains only traces of guanidine normally, this demonstration is taken as evidence of large quantities of purines in the blood which act as bases themselves and which readily decompose into stronger and more toxic basic substances including not only guanidine and methyl guanidine but also choline and neurine, as suggested by Pendergrass, Hayman, Houser and Rambo.[3] In continuation of this work we will endeavor to find simpler and more accurate quantitative methods so that a series of these determinations may be made.

We suggest then that the acute illness starting within a few hours or during radiation is due to the immediate products of nuclear destruction of which the increase of acid soluble phosphorus is an index. These products in turn act as strong bases causing an alkalosis and acting like monovalent salts as sodium bicarbonate and sodium citrate on all the cells of the body. This salt action may in itself cause widespread secondary destruction continuing the alkalosis, increases in purine bases and their more toxic decomposition products.

The protective action of calcium salts on the cell through decreasing its permeability has been brought out by Loeb,[20] and Osterhout[23] in biological systems, and by Mathews,[21] and Clowes[18] in physical systems. The work of Bancroft[22] and others emphasizes the antagonistic actions of calcium, magnesium, barium, iron, etc., against monovalent actions of sodium, potassium, lithium and ammonium. Calcium has been used in prophylaxis and treatment of radiation reaction more or less empirically, but we applied both to patients and animals primarily to determine if there might be a protective action against organic bases, these being ammonium derivatives, resulting from nuclear destruction. The results are illustrated by the cases cited below and in two dogs recovering after receiving a dosage which proved rapidly fatal to other dogs of equal size and weight.

Administered prophylactically the acute illness was slight. However, typical changes were noted in the phosphorus content of the blood, and the animals died. Calcium lactate seemed as efficient as calcium chloride and produced no untoward symptoms. From the results obtained with this small series of patients and experimental animals, it is suggested that calcium lactate be used only in treatment until further observations have been made as to the possible increased resistance to radiation of malignant cells following calcium administration. The protective action seems to apply to both immediate and delayed effects of radiation.

CASE REPORTS

Mr. W. C. R. (Case 41809), aged sixty-three.

Diagnosis. Carcinoma, antrum of stomach confirmed by operation, enlarged mesenteric lymph glands.

Operation. Posterior gastroenterostomy.

Roentgen Therapy. At this time the operative wound was healed and the patient was in fair general condition. The following is the record of the patient's response to a single erythema dose delivered directly over the tumor mass anteriorly and the treatment given for this nausea.

2:45 p.m.—Treatment finished and patient returned to his room. Shortly after this he became very nauseated and vomited several times every hour.

5:45 p.m.—Calcium lactate (3 per cent) intravenously 9 c.c.

Calcium lactate (3 per cent by mouth drams III every half hour for three doses. Was much improved and vomited only twice afterward.

8:00 p.m.—Ca. lact. (3 per cent) intravenously. No more vomiting. Comfortable night.

8:00 a.m.—Vomited again.

9:00 a.m.—Ca. lact. (3 per cent) 25 c.c. intravenously. The same by mouth every half hour for three doses.

9:15 a.m.—Nausea relieved. No vomiting. He was able to take a second dose of roentgen rays the same afternoon, with no resultant vomiting.

Mrs. A. W. (Case 43406), aged thirty-three.

Diagnosis. Squamous cell carcinoma cervix (section). Large ulcerating mass at cervix, fixation of pelvic organs, involvement of adnexa.

Operation. None.

Radiation Therapy. The patient received one course of radium therapy about six weeks previously with considerable relief from symptoms. The following is the record following one roentgen-ray erythema dose delivered over the pelvis anteriorly.

2:00 p.m.—Treatment finished and patient returned to room. Became very nauseated and vomited every 15–20 minutes.

6:00 p.m.—Ca. lact. (3 per cent) 10 c.c. intravenously; the same by mouth drams III every half hour.

6:30 p.m.—Nausea relieved.

9:00 p.m.—Again nauseated. Ca. lact. (3 per cent) 20 c.c. intravenously. The same drams III every half hour for three doses. Comfortable the remainder of night.

9:00 a.m.—Some nausea. Ca. lact. (3 per cent) 25 c.c. intravenously. Same, three doses drams III by mouth.

10:00 a.m.—No nausea. A second dose of roentgen rays the same afternoon with very slight nausea following.

Mr. H. F. (Case 39554), aged thirty-two.

Diagnosis. Adenocarcinoma, antrum of stomach proximal to pylorus (confirmed by operation), several enlarged glands found at operation.

Operation. Posterior gastro-enterostomy.

Roentgen Therapy. The patient at this time was in good condition.

8/25/24—12:40 p.m.—Treatment ended. Ca. lact. (3 per cent) 15 c.c. intravenously before removal to his room. No nausea following this.

8/26/24—12:00 m.—Treatment ended. Vomited just at end of treatment. Ca. lact. (3 per cent) 15 c.c. intravenously before removal to his room. Nausea and vomiting following this.

1:45 p.m.—Ca. lact. (3 per cent) 20 c.c. intravenously.

2:00 p.m.—Vomited once.

2:25 p.m.—Vomited once. No nausea following this. Soft diet in evening. Good appetite.

8/27/24—12:00 m.—Treatment ended. Ca. lact. (3 per cent) 20 c.c. intravenously before removal to room. No nausea after this.

SUMMARY

1. The phosphorus content of the blood in both patients and dogs has a definite relation to the dosage of roentgen rays and the tissue irradiated.

2. The large increases in phosphorus and decreases of amino acids and non-

	Date	H.P.	Ac.S.P.	Ca	N.P.N.	Uric Acid	Sugar	Amino Acid
Fasting	7/1/24	11.4	27.18	8.8	28	2.05	82.0	6.17
3 hr. after treatment		14.10	31.23	8.6	28.2	2.10	91.0	5.90

	Date	H.P.	Ac.S.P.	Ca	N.P.N.	Uric Acid	Sugar	Amino Acids
4 hr. after treatment	7/1	12.55	29.34	8.2	34.5	2.18	88.5	5.93
		12.45	29.79	7.9	35.3	2.10	93.2	5.80

protein nitrogen during the first hour following irradiation indicates a maximum initial effect upon the cell nucleus.

3. An early distinct alkalosis of the blood is probably brought about by nuclear destruction yielding purine bases.

4. The organism after moderate dosage rapidly returns to normal from this stage with a compensating mild acidosis in twenty-four hours.

5. This acidosis usually protects the organism against any untoward effects after the second or subsequent treatments.

6. Very heavy dosage or irradiation of large tumor masses is followed by gradually intensified alkalosis with lethal termination.

7. Here there is a secondary salt action with widespread cellular destruction of both nucleus and protoplasm accompanied by high non-protein nitrogen, uric acid and guanidine content of the blood.

8. The effects of irradiation are counteracted by substances which protect the cell, as cited above, namely, ether anesthesia, morphine, glucose and calcium lactate.

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PHYSICAL STANDARDS OF PROTECTION AGAINST ROENTGEN-RAY DANGERS*

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THE results of inadequate protection against the harmful effects of overdosage with roentgen rays that have been reported in the past are so appalling that a search for protection standards is one of the most important problems in roentgen-ray physics and roentgen-ray biology. Yet all efforts and attempts in this direction have, up to the present moment, been entirely empirical and have so far not progressed to the stage where systematic cooperation between physicists and biologists might form a basis for more conclusive practical results.

Nevertheless, we are now in possession of enough accurate physical data on roentgen-ray dosage and on the penetrative and scattering effects of the rays, that it seems feasible to undertake an organized attack upon certain phases of this problem. In this paper therefore, is presented an attempt to solve some of the physical phases of this problem, especially those which tend to make possible further progress in studying the protection question particularly from the statistical and biological points of view.

In this connection, attempts were made:

1. To determine the physical factors upon which the doses depend to which, under varying conditions of operating roentgen-ray tubes, an operator is exposed.

2. To collect data and to work out methods for calculating the effectiveness of protective materials and for calculating the thickness of such material required to produce a certain desired or predetermined degree of protection.

3. To determine the protective efficiency and adequacy of already existing roentgen-ray installations for various amounts of work performed, and then to find the average dose to which an operator, under conditions now considered satisfactory, can be exposed apparently without danger.

4. To derive simple formulae with which it is easy to calculate the roentgen-ray doses that have produced certain observed biological changes.

This paper is therefore intended to cover particularly the physical phases of the protection problem and in addition thereto there are considered some principles and designs of protective shields and tube housings.

At first thought it might appear simplest to design the protective shields and housing devices for roentgen-ray generators so heavy that their opacity would be sufficient to stop practically all rays from reaching the operator or bystanders. It is, however, obvious that the protective shields and apparatus would then become entirely too heavy, unwieldy and costly, so that we must deal with an equilibrium between the amount of protection obtainable and the weight and cost of the protective shields. Every operator therefore must be content to receive within a given time, a certain quantity dose of radiation[1] and it is to be determined, evidently from biological observations just what that dose shall be to which the average operator can be exposed without danger to his health. Then from the dose so found and agreed upon, there will have to be calculated the thickness or effectiveness of protective shields and tube housings.

A second question arises in this problem with respect to the best and most favorable location of protective shields, i.e., whether they should be located near the source of the rays or perhaps for better effectiveness nearer to the operator. As there is, however, no physical indication that the effectiveness of such materials does in any way depend on the intensity of the radiation, it follows that the fractional decreasing effect of a screen upon the rays does not depend in any way upon its location relative either to the source of the rays or

[1] There is really no absolute protection possible, for all substances transmit a certain quantity of rays and even from the theoretical point of view, it is necessary to consider an equilibrium.

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to the operator. So it is actually found both by calculation[1] and by experiment that the protective screen for equal protective effectiveness can be placed anywhere between the source of the rays and the operator, wherever it is most convenient and adequate for electrical insulation or the protection of the roentgen-ray tube and current generating apparatus.

However, the size or area of the protective screen is determined by its location. If close to the source of the rays, then the shield may be considerably smaller in area than if it is placed a greater distance away from the source. On this basis therefore, there is a good amount of argument possible in favor of a protective shield immediately surrounding the roentgen-ray tube simply because such a shield would be considerably less heavy and less expensive, while at the same time hardly less effective as a protective shield, than one of the same thickness but much larger and located a greater distance from the tube.

DERIVATION OF THE FORMULAE FOR CALCULATING THE EFFECTIVENESS OF PROTECTIVE SHIELDS

The intensity of a radiation a certain distance from the tube is calculated as the product of the millamperes times the time divided by the square of the distance. This can be conveniently expressed by the formula: $\frac{ma \times t}{D^2}$

In order to calculate the erythema dose from the intensity at the selected distance from the tube it is necessary to divide the reading of the milliampere-minutes by the factor 6800.[2] This factor is determined for a distance of 50 cm. and combining this operation with the above formula, we obtain: $\frac{ma \times t \times 50^2 \times 100}{d^2 \times 6800} = E$ or somewhat simplified this formula becomes

$$\frac{ma \times t \times 36.8}{d^2} = E = \text{erythemas} \quad . \quad . \quad . \quad (1)$$

The radiation dose thus found is at the given distance from the source of the rays and without protection shields. We will have then to decide upon a tolerance dose which can be considered harmless for the operator within a certain assumed period of time. This tolerance dose is at the present not definitely known but in the next chapter will be calculated the dose permissible per month on the basis of present standard installations. We therefore determine the percentage reduction that must be caused in the erythema dose as found with the above formula by the following proportion:

$$E. : T.\ D. :: 100 : x \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

The result x is the percentage reduction which must be produced with absorption material placed between the source of the rays and the operator.

In the table are given the percentage intensities of a radiation after it passes through various thicknesses of metallic lead or its equivalent. In the column headings are given the approximate average wave lengths produced at the various voltages at which a tube may be operated. Thus for regular roentgenographic and roentgenoscopic work the average wave length 0.30 Ångström is selected because even while a roentgenographic or roentgenoscopic tube may be operated at times with quite high voltages, it rarely happens that any great quantity of rays of a still shorter average wave length than 0.3 Å. is produced. For therapeutic apparatus the wave length 0.12 Å. is selected as representing the existing conditions, although under certain conditions it might also be possible that a somewhat shorter minimum wave length is produced. It does, however, not seem probable that any shorter average wave length is ever produced with the generally employed clinical therapy apparatus; as a rule, the average wave lengths thus far measured are considerably longer. From the percentage

[1] If we designate by d the distance between the source of the rays and the operator, and by x the location of the screen from the operator, anywhere between these two points, then the intensity of the radiation at the point x will be equal to $\frac{I}{(d-x)^2}$. The reduction due to absorption in the screen is $\frac{I}{b}$ and the further decrease of the radiation intensity when the rays reach the operator is $\frac{(d-x)^2}{d^2}$. Hence we get $\frac{I}{(d-x)^2} \times \frac{I}{b} \times \frac{(d-x)^2}{d^2}$ or, simplified, $\frac{I}{b} \times \frac{I}{d^2}$, which is the expression of the inverse square law showing that the location of the screen does not affect the intensity of the rays at the place of the operator.

[2] Regarding the origin of this constant, *vide*, Mutscheller, A. Ionometer for relative measurement of primary *x*-rays. *Radiology*, May, 1924, ii, 330–333.

reduction as above determined and with the voltage or wave length employed as above explained, the thickness of lead or equivalent protective material required is then read from the table.

The method outlined in the preceding section of calculating the dose which passes through a protection screen of given thickness and given distance from the source of the rays consists of two separate and distinct steps. In the first place there is to be calculated the dose which an operator would receive at the given distance from the tube, but with the protection screen absent. Then, in the second place, there must be calculated or determined the amount of reduction of that dose which must be caused with protective screens so that the dose to which the operator is actually exposed is not large enough to injure his health. We are at the present moment in possession of sufficient experimental data and information on the conditions as they exist in the typical clinical roentgen-ray laboratory so that with the previously outlined method we can calculate the actual dose which accumulates under the most varied conditions of operation, behind the screen or in any given place in the roentgen laboratory. Thus it is quite obvious that for instance, in the roentgenographic laboratory the average number of exposures, in the roentgenoscopic laboratory, the average duration of the examinations, and in the therapeutic laboratory the average time of treatments must be summed up over a convenient period of time. Therefore, quite naturally, in a very busy laboratory there must be taken much more extensive and elaborate precautions than in a laboratory in which only an occasional examination is made.

But there is still a third question; for, in order to be able to calculate the thickness of the protective material for a protection shield, there must be known the dose which an operator can, for a prolonged period of time, tolerate, without ultimately suffering injury, and to arrive at that dose, at least tentatively, several typical good installations and fair averages were taken as a basis for calculating the dose to which the operators are now exposed during the time of one month. Thus it seems that under present conditions and standards accepted at present, it is entirely safe if an operator does not receive every thirty days a dose exceeding $\frac{1}{100}$ *of an erythema dose*, and from the present status of our knowledge this seems to be the *tolerance dose* for all conditions of operating roentgen-ray tubes for roentgenography, roentgenoscopy and therapy. This dose, however, is derived from the average of a limited number only of typical examples, and is perhaps not yet sufficiently checked biologically and so it may happen that in the future this dose will have to be changed either to a larger or a smaller practical tolerance dose. Therefore, close cooperation between physicists and biologists and a systematic cooperation of roentgenologists, and careful examination of the blood and other organs of roentgen-ray operators will decide this point.

We have now arrived at a stage where we have a method to calculate, with full consideration of the most varied conditions of operation, the dose which comes through a protection shield of given thickness. Then we also have tentatively agreed upon a tolerance dose that may be safe and permissible without the necessity of constructing too heavy, clumsy and unwieldy protection screens and shields. We should therefore now be able to perform the reverse operation and to calculate the correct thickness of protective shields and protective screens for any given conditions of operation or any given conditions that may exist in various roentgen-ray laboratories. This is indeed the operation which would be most often performed and it is the operation for which this method is primarily worked out.

For the purpose of making such a calculation, we shall now assume the following given conditions of operation and calculate the thickness required of metallic lead so that the operator does not receive a dose within thirty days that exceeds the admitted tolerance dose of $\frac{1}{100}$ of an erythema dose. We shall assume:

A. A roentgenographic apparatus being used for an average of 50 exposures per day of 5 sec. each with 20 ma.; or

B. A roentgenoscopic apparatus being actuated for 2 hrs. per day with 4 ma.; or

C. A deep therapy tube being actuated with 4 ma. for 10 hrs. per day.

Then in case of total absence of any protective material at an assumed distance of 10 feet from the source of the rays, there would be produced in one month of time, the following doses:

$$\text{A. } \frac{50 \times 5 \times 20 \times 30 \times 36.8}{60 \times 305^2} = 0.99$$

erythema doses

$$\text{B. } \frac{2 \times 60 \times 4 \times 30 \times 36.8}{305^2} = 5.70$$

erythema doses

$$\text{C. } \frac{4 \times 60 \times 10 \times 30 \times 36.8}{305^2} = 28.5$$

erythema doses

These doses then will have to be reduced to the tolerance dose agreed upon, which operation is performed with the aid of formula No. 2, or if the tolerance dose is accepted as $\frac{1}{100}$ of an erythema dose then we find the percentage to which these doses must be reduced to be:

$$\text{A. } \frac{1}{0.99} = 1.01 \text{ per cent}$$

$$\text{B. } \frac{1}{5.70} = 0.175 \text{ per cent}$$

$$\text{C. } \frac{1}{28.5} = 0.035 \text{ per cent}$$

The next step consists in selecting the proper thicknesses of protective material to cause the reduction of the radiation intensity to the above found percentages of transmitted radiations; the actual thickness of absorption substance can then be directly arrived at either by calculation with the known absorption coefficients of lead or by reading the thickness required from a table prepared for this purpose.

Such a table is given herewith and from it is directly obtained the percentage reduction of radiations of different wave lengths or various lead thicknesses. From this table we read the following thicknesses of lead required to produce the necessary reduction of radiation intensity to which within one month at a distance of 10 feet from the tube and in back of the lead screen not more than $\frac{1}{100}$ part of an erythema dose is obtained.

We find that there are required for:

A. The roentgenographic equipment operating with an average wave length of 0.17 Å., a minimum of 1.2 mm. of metallic lead;

B. The roentgenoscopic equipment operating also with an average wave length of 0.17 Å. requires a minimum thickness of 1.8 mm. of metallic lead;

C. The therapeutic apparatus operating under the conditions stated above at an average wave length of 0.12 Å. requires a thickness of 5.6 mm. of metallic lead.

As might readily be expected, the question of scattering of the radiation plays a very important part. Since it is well known that objects, especially metallic objects, when exposed to highly penetrating rays, emit a profuse and highly penetrating radiation, it could be concluded that if no such objects were exposed to the rays there would be less danger of over radiation. Furthermore, in view of the fact that the scattered rays are being emitted from such objects in all directions, they cannot be effectively screened off by protective screens placed in the direct path of the rays from the tube, but the scattered rays rather produce the effect of passing "around the corner." It would, therefore, seem that a small screen behind which the operator may be placed is not at all effective as a protection device, no matter how thick its walls. There remain two other ways in which satisfactory protection against scattered rays is obtainable, namely, either to completely enclose the tube with a lead lined housing, or to enclose the operator in a booth closed on all sides.

That the latter method is not practically feasible is quite obvious for the requirements for ventilation, and illumination by daylight would be made so difficult and unsatisfactory that operators would suffer from the lack of air and light with consequences as grave and serious as those from over-dosing with roentgen rays. While the preferred method would be to surround the tube with protective material, it is still to be decided whether the treatment room should be lead lined or whether the tube should be placed in a small lead lined housing. This question will evidently

be decided by a decision whether the patient is to be exposed to the diffused scattered radiation in addition to the directed primary application of the rays, or whether only the lesion to be treated should be irradiated, a minimum of rays being received by other parts of the patient's body. This is a clinical question, and can therefore not be decided in a discussion of physical problems.

From the practical point of view, however, there is this to be considered, that if a small lead glass bowl surrounds the body of the tube, but which is open on top and through the sides of which the tube arms project, it cannot produce any satisfactory amount of protection for the operator no matter how thick or heavy its wall may be. The tube arms and upper part of the bulb are obviously transmitting practically the full amount of the diffuse radiation inside of the bulb, which as is known constitutes about 50 per cent of the intensity of the rays generated in the tube. For the protection of the operator, therefore, there is only the necessary protection provided, either if he is enclosed in a completely lead lined booth, or the therapy room

TABLE GIVING THE PERCENTAGES OF RAYS TRANSMITTED THROUGH VARIOUS THICKNESSES OF METALLIC LEAD OR THEIR EQUIVALENT THICKNESSES OF LEAD SALTS

Cm. Lead	Average Wave Length										
	0.10	0.11	0.12	0.13	0.14	0.15	0.16	0.17	0.18	0.19	0.20
	Absorption Coefficient										
	14.3	16.2	18.5	21.3	24.5	28.1	32.3	37.1	42.3	48.3	54.9
0.10	23.89	19.75	15.69	11.86	8.606	6.002	3.941	2.438	1.448	0.794	0.410
0.12	17.94	14.28	10.83	7.739	5.269	3.419	2.064	1.160	0.621	0.302	0.137
0.14	13.48	10.33	7.480	5.052	3.226	1.948	1.081	0.552	0.266	0.115	0.046
0.16	10.12	7.465	5.165	3.298	1.975	1.110	0.566	0.263	0.114	0.044	0.015
0.18	7.601	5.397	3.566	2.153	1.210	0.632	0.297	0.125	0.049	0.017	0.005
0.20	5.708	3.902	2.462	1.406	0.741	0.360	0.155	0.059	0.021	0.006	0.002
0.22	4.287	2.821	1.700	0.918	0.453	0.205	0.081	0.028	0.009	0.003	0.001
0.24	3.220	2.040	1.174	0.599	0.278	0.116	0.043	0.013	0.004	0.001	
0.26	2.418	1.475	0.810	0.391	0.170	0.067	0.022	0.006	0.002		
0.28	1.816	1.066	0.560	0.255	0.104	0.038	0.012	0.003	0.001		
0.30	1.364	0.771	0.386	0.167	0.064	0.022	0.006	0.001			
0.32	1.024	0.557	0.267	0.109	0.039	0.012	0.003				
0.34	0.769	0.403	0.184	0.071	0.024	0.007	0.002				
0.36	0.578	0.291	0.127	0.046	0.015	0.004	0.001				
0.38	0.434	0.211	0.088	0.030	0.009	0.002					
0.40	0.326	0.152	0.061	0.020	0.005	0.001					
0.42	0.245	0.110	0.042	0.013	0.003						
0.44	0.184	0.080	0.029	0.008	0.002						
0.46	0.138	0.058	0.020	0.006	0.001						
0.48	0.104	0.042	0.014	0.004							
0.50	0.078	0.030	0.010	0.002							
0.52	0.058	0.022	0.007	0.002							
0.54	0.044	0.016	0.005	0.001							
0.56	0.033	0.011	0.003								
0.58	0.025	0.008	0.002								
0.60	0.019	0.006	0.001								
0.62	0.014	0.004									
0.64	0.011	0.003									
0.66	0.008	0.002									
0.68	0.006	0.002									
0.70	0.004	0.001									
0.72	0.003										
0.74	0.002										
0.76	0.002										
0.78	0.001										
0.80	0.001										

is completely lead lined and the operator is stationed outside of the therapy room.

On the other hand, when the tube is completely enclosed with protective material and only a small opening is left for the useful rays to emerge, there are to be taken into account the scattered rays formed within the patient and in the objects in the direct beam of the rays. Generally the rays scattered by the osseous structures of the patient's body, or by the metal or concrete composition of the floor or table, are of sufficient intensity so that the operator, in order to be safe, must still be further protected against the rays coming from the patient and objects exposed to the beam of the rays. This is adequately done with a simple lead screen which should be closed and protected on three sides. The actual amount of the scattered radiation under these conditions, is considerably smaller due to the fact that the exposed volume is very much smaller and generally at a considerable distance from the location of the operator.

As outlined in the preceding discussion, the routine of calculating the correct thickness of lead for protective screens under varied conditions of operating the roentgen-ray tube consists in the following steps:

1. Calculating with formula No. 1 the erythema dose which an operator would receive in case no protective screens are present;

2. Calculating with formula No. 2 the requisite percentage reduction necessary to reduce the intensity of the radiation down to that dose which has been found or admitted to be safe and harmless.

3. Reading from the table the thickness of lead or equivalent protective material required to cause the intensity reduction found necessary by computation with formula No 2. This would then be the permissible minimum thickness of protective material, and if it is found feasible regarding cost, weight and difficulty of manipulation, this thickness can be further increased to any desired degree of protection.

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Standardization Committee: WM. DUANE, Chairman, Boston, HENRY SCHMITZ, Chicago, A. WEATHERWAX, Philadelphia.

EDITORIALS

THE PROPAGANDA FOR REFORM

Our editorial in the November, 1924, issue of the Journal entitled "Our Own Propaganda for Reform" has brought forth the following editorial comment in the New York Medical Week of December 20, 1924:

"In the American Journal of Roentgenology and Radium Therapy for November the suggestion is made that the American Roentgen Ray Society, through its committee on Laws and Public Policy, establish a Propaganda for Reform in its specialty, analogous to that conducted by the American Medical Association for the entire domain of medicine. The Journal volunteers to support such a program by the use of its columns and editorial aid.

"No one who is familiar with the extrinsic difficulties that have beset the progress of roentgenology can doubt the merit of this suggestion. The appeal which the *x*-ray holds for popular imagination lends itself readily to exploitation by charlatans. As a result, a branch of medicine which requires trained specialists is being practiced by large numbers of unqualified technicians and quacks. The roentgenologists will at once protect the public and safeguard their specialty by pursuing the aims proposed in their journal.

"This is not the first time that a group of specialists have employed their scientific association to cleanse their specialty of incompetence and fraud. The Section on Oto-Laryngology of the American Medical Association has long been seeking practical means to formulate and maintain standards for the treatment of ear, nose and throat disease. These examples might well be followed by other special sccieties, which can furnish a valuable supplement to the excellent work being done by the Bureau for Propaganda and Reform of the A. M. A."

We believe that one of the most valuable methods in any effort at reform is publicity. Readers are therefore requested to send to the Journal news notices, advertisements, or other material which illustrate any of the many ways in which the roentgen ray is used to defraud or mislead the medical profession and the public. On page 76 of this issue we are reproducing the report of a chiropractor and the roentgenogram on which it is based. How utterly ridiculous such a report is can be fully understood only by roentgenologists or orthopedic surgeons who are in the habit of studying carefully made stereoscopic roentgenograms of the spine.

RECOGNITION OF ROENTGENOLOGISTS

AN INDICATION OF THE INCREASING IMPORTANCE OF ROENTGENOLOGY IN INTERNAL MEDICINE AND SURGERY

There have been many recent indications that roentgenology is filling an increasingly important place in both medicine and surgery. One of these indications is the large number of medical colleges in this country that now have separate and fully equipped roentgen departments in charge of a professor of roentgenology. This condition of affairs is so common now in our best colleges that the editor of this Journal was astonished upon a recent visit to one of our great schools to find little or no provision for teaching roentgenology. Here was a college magnificently equipped and manned for teaching and research in every other department but apparently the only place where roentgen work is done at all is in the department of anatomy. There presumably most of the work would be done on cadavers and would be interpreted by an anatomist.

The idea is still held by some teachers of internal medicine and surgery that roentgenology is not a special branch of medicine and surgery but that all its data may be communicated to students in the various other courses of the curriculum. We think that little argument is needed to prove that roentgenology has come to stay as a medical specialty. The mere fact that practically every advance in roentgen diagnosis has been brought about by the work of roentgenologists who have been specialists in this line should be

sufficient indication that future advance may be expected only if this branch of medicine remains in the hands of men especially interested in it and especially equipped for it.

The idea that medical students can be given any adequate grasp of this subject through casual mention of the roentgen findings in various diseases by teachers of internal medicine, surgery, or the various special branches, we believe to be erroneous. It is, of course, necessary to correlate the teaching in the department of roentgenology with that of all other departments, but the student will leave college with a broad knowledge of the value of the roentgen ray in clinical medicine only if he has been under the instruction of a teacher well qualified to give him such knowledge. To contend that it is impossible to give an undergraduate the information and experience necessary to make him a specialist in roentgenology, and that therefore there is no reason for a special course in this subject is not to the point. The same argument would apply to many other subjects which occupy very important places in the curriculum. Only a small percentage of medical students will become specialists in pathology or bacteriology, but it is nevertheless considered essential to give every one an extensive course in these subjects in special departments under the direction of specialists in these branches.

The majority of Class A medical colleges have given roentgenology recognition commensurate with its importance and we have no doubt that in the near future no medical college in this country will be considered a fully equipped and well balanced institution for teaching medicine unless it has a modern roentgen department under the direction of a roentgenologist who occupies a dignified place in the faculty.

It is not only in medical schools, however, but among the profession at large that the roentgenologist is being given a place on a par with his colleagues in medicine. There are many gratifying indications of this tendency on the part of internists, surgeons, and specialists to accept the roentgenologist as a consultant on an equal plane with themselves. This is of sufficiently recent development to be worthy of remark. Elsewhere in this issue of the Journal will be found news items announcing the appointment of the head of the roentgenological department of one of our great universities as temporary administrative head of the department of internal medicine, and of the election of a roentgenologist as president of the Medical Society of the District of Columbia. For the past year a roentgenologist, Dr. Fred M. Hodges, has been president of the Academy of Medicine of Richmond, Va. In fact roentgenology has attained a particularly enviable standing in Virginia because of the high type of the men who represent it throughout the state, but it is not too much to say that the unusual recognition accorded it there is probably due to the ability and character of a pioneer representative of our specialty, Dr. Alfred L. Gray of Richmond. For many years Dr. Gray has occupied an influential position in the medical councils of his state and throughout the South. As dean and teacher in his medical college, as president of the Richmond Academy of Medicine and of the Virginia State Medical Society, he has constantly worked for the advancement of medicine in general, and roentgenology in particular.

We could continue to name roentgenologists who have been honored by their colleagues in their local communities but these few examples serve to illustrate the point that the importance of roentgenology is being recognized by the profession at large. Along with this recognition and the honors bestowed upon representatives of our specialty goes increased responsibility. We must accept the burden of the research work necessary to clear up many important questions, that is, we must continue to contribute to the advancement of medical science as we have in the past. We must not only work for perfection in technique, which is the foundation of roentgenology as an art, but our background and training must be such that we can evaluate our findings in the light of a broad general knowledge of medicine. In a word, we must fit ourselves to occupy the high place as medical consultants which our

confrères are now showing themselves willing to bestow upon us.

APPOINTMENT OF A PHYSICIST TO THE CHAIR OF ROENTGENOLOGY

The recent appointment to the chair of roentgenology in a prominent medical college of a gentleman who does not hold a medical degree revives a question which is of the greatest interest to all roentgenologists. The fact that Class A hospitals all favor medical men as roentgenologists has been of much assistance in the development of a proper appreciation of the importance of roentgenology as a medical specialty.

The proprietors of the various non-medical *x*-ray laboratories will now undoubtedly take fresh heart and cite this appointment as evidence that the profession is not a unit in its recognition of the standards of roentgenology.

No matter how well trained an individual may be in some phases of roentgenology it is certain that unless he has had a liberal medical education his services will be less efficient because of his lack of the broad view of medicine which ordinarily comes only to a medical graduate with thorough medical training and the proper background of hospital and practical experience.

That a knowledge of physics and technique is necessary to the practice of roentgenology is recognized by everybody, but that the ultimate object of roentgenology is the diagnosis and treatment of disease should be apparent to all. A teacher of roentgenology without medical education and experience is therefore an anachronism that no modern medical college should tolerate.

At the present time when the battle which the devotees of various cults are waging against the medical profession is fiercely fought, it seems hard to realize the motives which prompted the authorities of the college in question to make such an appointment. From a practical standpoint, owing to the many ramifications of roentgenology in its varied uses by so many different specialties in medicine, the shortsightedness of such a policy is very apparent.

The announcement of this appointment has created much adverse criticism and this editorial is written as a protest against such an appointment. It is sincerely hoped that this ill-advised action will not be taken as a precedent by any other educational institution in the country.

DEATH OF PROFESSOR BERGONIE

The recent death of Professor Bergonié of Bordeaux, accounts of which have been widely published in the public press, has removed another of the pioneer workers and investigators in the field of radiology. A full account of his life and work will be published in the next issue of the Journal.

Subscribers to THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY *visiting New York City, are invited to make the office of* THE JOURNAL *(69 East 59th Street, New York) their headquarters. Mail, packages or bundles may be addressed in our care. Hotel reservations will gladly be made for those advising us in advance; kindly notify us in detail as to requirements and prices. List of operations in New York hospitals on file in our office daily.*

SOCIETY PROCEEDINGS, CORRESPONDENCE AND NEWS ITEMS

Items for this column solicited promptly after the events to which they refer.

MEETING OF CENTRAL SECTION, AMERICAN ROENTGEN RAY SOCIETY, DETROIT, MICH., FEB. 19–21, 1925

PROGRAM

THURSDAY, A. M., FEB. 19, 1925

Symposium on Breast Tumors.

1. Pathology, Dr. P. F. Morse, Detroit, Michigan.
2. Surgical, Dr. J. C. Bloodgood, Baltimore.
3. Roentgen Therapy, Dr. W. A. Evans, Detroit, Michigan.
4. Roentgen Therapy, Dr. A. U. Desjardins, Rochester, Minnesota.
5. Radium Therapy, Dr. C. F. Burnham, Baltimore, Maryland. Discussed by Dr. E. A. Codman and others.

THURSDAY, P. M., FEB. 19, 1925

Symposium on Bone Malignancy.

1. Radiologic-pathologic Conference on Bone Sarcoma, Dr. Warthin and Dr. Hickey.
2. Diagnosis, Dr. A. E. Codman, Boston, Massachusetts.
3. Roentgenologic Differential Diagnosis, Dr. A. B. Moore, Rochester, Minnesota.
4. Roentgen Therapy, Dr. Leucutia, Detroit, Michigan.
5. Surgical Treatment,

THURSDAY EVENING, FEB. 19, 1925

Address on Cancer—by A. E. Codman, Boston, Massachusetts.

FRIDAY, A. M., FEB. 20, 1925

1. Paper on some phase of "Physics of Roentgen Therapy"—Dr. A. W. Erskine, Cedar Rapids, Iowa.
2. "Teratoid Tumor of the Testicle with Metastasis in the Lungs"—Dr. E. A. Pohle, Cleveland, Ohio.
3. Subject unannounced—Dr. R. H. Stevens, Detroit, Michigan.
4. Subject unannounced—Dr. L. R. Sante, St. Louis, Missouri.
5. Subject unannounced—Dr. E. A. Ernst, St. Louis, Missouri.

FRIDAY, P. M., FEB. 20, 1925

1. Subject unannounced—Dr. H. P. Doub, Detroit, Michigan.
2. Subject unannounced—Dr. B. H. Nichols, Cleveland, Ohio.
3. "The Surgical and Roentgenological Significance of the Structure of the Hands of the Same Individual"—Dr. E. C. Hill, Johns Hopkins Medical School, Baltimore, Maryland.
4. "Brain Surgery, Illustrating the Value of Ventriculograms in Diagnosis"—Dr. Peet, Ann Arbor, Michigan.
5. Subject unannounced—Dr. E. S. Blaine, Chicago, Illinois.

FRIDAY EVENING, FEB. 20, 1925

Annual Banquet—Address, "Diagnosis of Kidney Lesions"—Dr. W. F. Braasch, Rochester, Minnesota.

SATURDAY, A. M., FEB. 21, 1925

1. Subject unannounced—Dr. Lawrence Reynolds, Detroit, Michigan.
2. Subject unannounced—Dr. Charles Eastmond, Brooklyn, New York.
3. "Roentgenographic Demonstration of the Adenoid"—Dr. C. C. Grandy, Ft. Wayne, Indiana.
4. "Roentgenographic Evidences of the Healing of Pulmonary Tuberculosis"—Dr. J. Burns Amberson, Jr., Loomis, New York.
5. "Diaphragmatic Hernia"—Dr. E. L. Jenkinson, Chicago, Illinois.

SATURDAY, P. M., FEB. 21, 1925

1. "Fractures of the Os Calcis"—Dr. Archie Hull, Detroit, Michigan.
2. "Bone Pathology of the Mound Builders"—Dr. Hugh Means, Columbus, Ohio.
3. "The Roentgenologic Study of the Appendix: Biological and Anatomical Background"—Dr. E. H. Skinner and Dr. E. R. Deweese, Kansas City, Missouri.
4. "A Report on the Graham Method of Gall-bladder Investigation"—Dr. Sherwood Moore, St. Louis, Missouri.
5. Subject unannounced—Dr. Thomas Burcham, Des Moines, Iowa.

SATURDAY EVENING, FEB. 21, 1925

Lantern Slide Exhibit.

MEETINGS OF THE ROENTGEN SOCIETIES

We contemplate the publication of a list of roentgen society meetings such as that below, in each issue of the Journal, gradually adding other home and foreign societies as the information reaches us. Secretaries of societies not here listed are requested to send the necessary information to the editor.

New York Roentgen Society
Secretary, Dr. Eugene V. Powell, 217 East 42d St.
Meets monthly on second Monday, New York Academy of Medicine.

The Canadian Radiological Society
Secretary, Dr. E. C. Brooks, Montreal.
Annual meeting, Regina, Sask., June 15–19, 1925.

Roentgen Ray Society of Central Pennsylvania
Secretary, Dr. W. E. Reiley, Clearfield, Penna.
Two meetings a year, April and October.

The New England Roentgen Ray Society
Secretary, Dr. Frank E. Wheatley, 520 Beacon St., Boston, Mass.
Meets monthly on third Friday, Boston Medical Library.

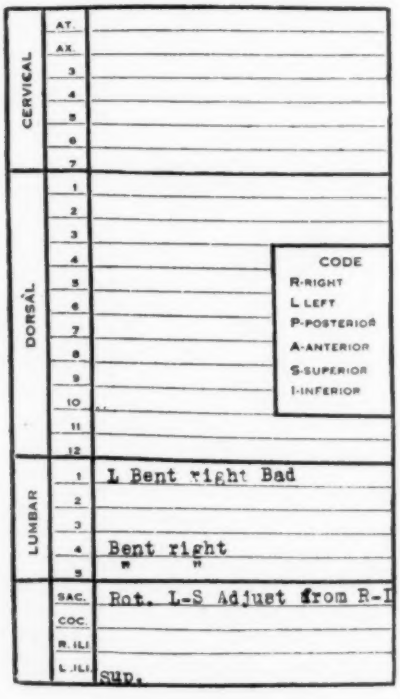
Philadelphia Roentgen Ray Society
Secretary, Dr. Eugene Pendergrass, University of Pennsylvania, Philadelphia.
Meets monthly on first Thursday evening, Pennsylvania Hospital.

ROOM FOR REFORM

In reply to the editorial in the November number of the Journal entitled "Our Own Propaganda for Reform" a roentgenologist has sent us the so-called "x-ray report" which we publish below, with the roentgenogram upon which this report is based. Our correspondent forwards them with the following remark: "Inclosed please find a film of the lumbar spine which was taken by a chiropractic in New York City. The inclosed report speaks for itself and is certainly good evidence for propaganda for reform in roentgenology. This evidence was given to me by the mother of the patient."

Editorial comment on this will be found on page 72.

FIG. 1. Roentgenogram upon which a chiropractor based the report given below.



9881 REMARKS

There is a right Rotation in the lumbar region.

Pelvis tilted-L-S

Major Subluxations:
Lumbars-1
Sacrum

FIG. 2. A chiropractor's report of roentgenogram examination.

CANCER OF THE LIP

EDITOR'S NOTE. The following letter of Dr. Bloodgood was published in the Journal of the American Medical Association, November 24, 1923, and has recently been sent by Dr. Bloodgood to the editor of this journal, with request for publication with editorial comment. It deals with a subject still under discussion, as is shown by quotations from an article by Douglas Quick in "Radium Report of the Memorial Hospital," which we publish following Dr. Bloodgood's letter.

Readers of the Journal are requested to discuss this subject in these columns and to present evidence in support of their views. There is little doubt that many roentgen and radium therapists have had experiences similar to that described by Dr. Bloodgood, namely, that they have been called upon to treat recurrent carcinoma of the lip, the only difference being that the original treatment was surgical excision.

EXCISION OF A V-SHAPED PIECE OF THE LOWER LIP VERSUS ROENTGEN-RAY OR RADIUM TREATMENT

To the Editor. This morning (Nov. 3, 1923) a patient presented himself with a mass the size of an egg in the submental area and apparently somewhat fixed to the lower jaw. In March, seven months ago, a small ulcer on the lower lip was subjected to radium treatment and has healed, leaving a slight, umbilicated scar. The lesion, whatever its nature, had been present three months. It occupied the mucocutaneous border of the middle third of the left lower lip. It had apparently begun as a smokers' burn in a patient with bad teeth.

These cases are increasing in number. That is, the lesion on the lip heals, or apparently heals, after the application of roentgen rays or radium, and then, a few months or years later, glands appear in the neck, which, when removed, prove to be metastatic carcinoma.

I would appreciate an opportunity to present to the larger audience of the readers of The Journal the following facts:

Some years ago I made one report on the operative treatment and results of cancer of the lip, and there is in preparation a second report on a larger number of cases. The conclusions of the first report are confirmed by the restudy of both old and new material, and the ultimate results up to date.

If the lesion on the lip can be excised with a V-shaped piece and the wound closed without a plastic operation, there has never been a local recurrence, irrespective of the pathologic condition, whether the lesion was benign or malignant. This operation can be done under procain within one-half hour, and the patient should not lose more than a few hours from work.

The cost of such a minor operation in material and in time of patient and operator is small as compared with that of any other treatment, and it is my opinion that the results are the best.

The piece excised from the lower lip is subjected to microscopic study, and if the sections show cancer, the glands of the neck are removed (this can also be done under procain). When these glands show no evidence of metastasis, the percentage of cures has been 100. When the glands have shown metastasis, the percentage of cures in the first report was 50, and in the second report will be somewhat larger.

Now that the community is educated to seek advice early, the moment the lesion is observed on the lower lip, I am able to divide the cases observed and reported by me into the following classes:

1. The lesion on the mucocutaneous border of the lower lip is small, of short duration—a few days up to two weeks; it is of the type of a burn, a fever blister, a vesicle, keratosis or a wart. The patient smokes or chews; the teeth may be ragged and dirty. The majority of these lesions heal by removal of the causes—tobacco and ragged, dirty teeth and instructing the patient to keep the teeth clean and the lip lesion covered with petrolatum.

2. The lesion is of longer duration, but still distinctly benign—leukoplakia, or the

chronic chapped lips of the smoker. Such lesions disappear when tobacco in every form is removed.

3. The lesion of the first group does not disappear under treatment, or, when seen, is of longer duration. In this group one cannot distinguish between the benign and the malignant, clinically.

4. The lesion is distinctly benign—a wart.

5. The lesion is distinctly cancer.

Groups 3, 4 and 5 should be subjected to immediate local excision under procain, and the operation on the glands of the neck performed, if the microscope pictures carcinoma in the primary lesion.

If, instead of operation, these patients are subjected to radium, roentgen rays, caustic paste, fulguration, cautery—all without microscopic study—the lesion in the first group will be permanently cured, but the treatment deserves no more credit than the treatment by the removal of the cause and cleanliness.

In Group 2, no treatment is of any value, unless the cause (tobacco) is removed, and if this is done any other treatment is unnecessary.

In Group 3, any other treatment that does not permit a microscopic study will lead to the false conclusion, in many of the cases, that the treatment has cured a local cancer; and if the local lesion is malignant, just as in Group 5, the removal by operation, or the destruction or healing by any other treatment, is but a minor part of the treatment. It is essential to ascertain whether the local lesion is cancer, and if it is, to remove completely the glands in the submaxillary and submental areas. Today there is every evidence that complete removal of the glands of the neck offers more than any other known treatment. There is apparently no objection to irradiate, either with roentgen rays or with radium, the lymphatic area before and after the thorough removal of the glands; but there seems no question that the removal of the glands is the essential feature. In those cases in which the microscope fails to show metastasis, postoperative irradiation is unnecessary.

I am willing to submit the accumulated evidence in the Surgical Pathological Laboratory of the Johns Hopkins Hospital to any investigating committee for comparison with roentgen-ray, radium or any other type of treatment. This second paper will soon be published. In view, however, of the growing tendency of members of the medical profession, not surgeons, to refer their patients with early lesions of the lower lip for roentgen-ray and radium treatment, it was my opinion that this warning, based on thirty years' experience with more than 500 cases should be made, if possible, with the largest publicity.

At the present time more than 60 per cent of the lesions that I have excised from the lower lip are microscopically benign, and of the remaining 40 per cent, in more than 75 per cent the glands, when removed, show no evidence of metastasis.

JOSEPH C. BLOODGOOD

"Surgical experience with cancer of the lip has been relatively favorable, compared with the results obtained in epidermoid carcinoma elsewhere. Ewing quotes Fricke as placing the cures at 60 per cent and Steiner at 70 per cent for a five-year period. He also notes that surgical experience emphasizes the necessity of a bilateral neck dissection. Ribera y Sans reports 96 operative results, with 2 deaths, and 80 apparently cured, although not all of these have passed even the three-year period. In a series of 200 cases Dollinger reports 158 primary lesions in which operation gave 70.7 per cent free from disease for three years and 69.6 per cent for five years. In a report of 33 cases Bloodgood found 26, or 78.7 per cent, well for five years. In 21 of these cases no metastases were found in the lymph-nodes removed, and of this group 20, or 95 per cent, remained well five years. Of 12 cases showing metastases in the nodes only 6, or 50 per cent, remained well five years, In a series of 516 cases operated upon, Broders was able to trace 306. Of the group traced, 182, or 59.5 per cent, were living and 169 or 92.8 of the living were free from disease. The average duration of the postoperative period was 7.76 years. One hundred and five patients with metastases were operated upon and of

these 69 were traced: 12 were living, and of these 10 were free from disease for periods ranging from 3.29 to 11.73 years. No patient with extension to the deeper cervical lymph-nodes, or to more than one group of nodes, was known to be alive. Von Bonsdorff places three-year curves at 80 per cent and has made the further interesting observation that 90 per cent of recurrences occur before the end of the third year. The difficulty of tracing post-therapeutic lip cases, especially, is very great, because many patients cannot be impressed with the seriousness of their condition and disappear from observation immediately the lesion or wound is healed. For this reason statistics are only approximately correct, and it would be by no means fair to classify as unfavorable all patients who failed to report their condition subsequently. However, a fair approximation would seem to place the results at about 70 per cent clinically free of disease for a five-year period.

"Such results would be excellent were they not obtained at the expense of great sacrifice of tissue. It is true that the radical surgical procedure, with a seven-out-of-ten chance of winning, is but a slight sacrifice in dealing with a disease which is so often fatal. It is also true that, as long as we offer such a procedure as the final word, the average layman will hesitate to accept it until his best chance is lost. While it is no fault of surgery that he hesitates, it is nevertheless human nature.

"The surgical procedure itself is open to criticism on two points. In dealing with the primary growth the usual method is the V-shaped incision. While this is termed a deformity of no consequence, it is nevertheless an uncomfortable deformity in most instances, especially if an adequate operation has been done. The base of this incision is upward whereas the broad spreading infiltrating base of the neoplasm is downward. When we consider the two types of lip epithelioma, it is at once evident that the greater amount of tissue is sacrificed in dealing with the less malignant of the two forms; and it is undoubtedly, in many cases, the hesitancy on the part of the surgeon to make a sufficient sacrifice that accounts for so many local recurrences in the scar. To say the least, the method is both awkward and unscientific.

"In dealing with the cervical nodes the routine bilateral block dissection is followed as the orthodox procedure. This surgical viewpoint has been forced by the fact that a much higher death-rate ensues, once metastases have become firmly established in the glands. Bloodgood's report of 20 out of 21 cases, in which no metastases were found in the nodes after removal, remaining well five years, is indeed strong evidence in favor of early block dissection of the neck. Only 50 per cent of his cases with glandular involvement remained well five years. In Broders' statistics of 516 cases operated upon, the regional nodes were removed in 449 cases, or 87 per cent. Of these, glandular metastases were found in only 105, or 23.38 per cent. In other words, 344 patients, or 76.6 per cent—at least nearly that number, allowing for some failures to demonstrate existant metastases—were operated upon unnecessarily. If every case with cancer of the lip is to be subjected to such a blanket rule, an appalling number of unnecessary operations must be undertaken. The method does seem unscientific . . .

"*Conclusions.* In our opinion the primary lesion in epithelioma of the lip should be managed entirely by the use of radium. For the average case surface radiation is sufficient, while in a few of the most deeply infiltrating lesions this surface application should be supplemented by the use of radium emanation embedded interstitially.

"The cervical nodes should be treated conservatively. External radiation to the neck is indicated at once in all cases admitted for treatment. Following this, cases without palpable nodes should be kept under observation after a sufficient period of external radiation. If nodes are present or appear subsequently, a complete unilateral neck dissection under local anesthesia, coupled with the use of radium emanation in very weak tubes buried throughout the wound, is indicated. Dissection of the opposite side may be done subsequently if indicated by the presence of nodes. External radiation following

operation is advisable in the majority of cases.

"While the time factor is still too short to permit of comparison with surgical statistics, we feel convinced from our experience in this group of unselected cases that radium deserves the foremost place in the treatment of lip cancer. If properly applied it bids fair to produce results surpassing our present surgical statistics. These results can be obtained with a minimum sacrifice on the part of the patient. Except in the event of a neck dissection, his daily work need not be appreciably interrupted. The resultant scar is, in most instances, scarcely discernible. By the conservative treatment of cervical nodes a vast amount of needless surgery can be eliminated. All this tends to remove doubt and fear from the mind of the patient and promises to bring him for advice and treatment at an earlier and more favorable time in the course of his disease than heretofore."

NEWS ITEMS

From the Ann Arbor *Free Press:* "Dr. Preston M. Hickey, professor of Roentgenology, in the medical school of the University of Michigan, has been named executive head of the department of internal medicine, by action of the faculty of the school. Dr. Hickey will serve in the new capacity in the absence of Dr. Louis M. Warfield, who has been granted a leave of absence until June 30, 1925."

Dr. Thomas A. Groover of Washington, D. C., was recently elected President of the Medical Society of the District of Columbia for the year 1925.

DEPARTMENT OF TECHNIQUE

Department Editor: DAVID R. BOWEN, M.D., Pennsylvania Hospital, Philadelphia, Pa.

In this department will be published from time to time, as material is available, suggestions for improvement in technique.

A CODE SYSTEM FOR CROSS INDEXING RECORDS

BY SAM W. DONALDSON, M.D.

ANN ARBOR, MICHIGAN

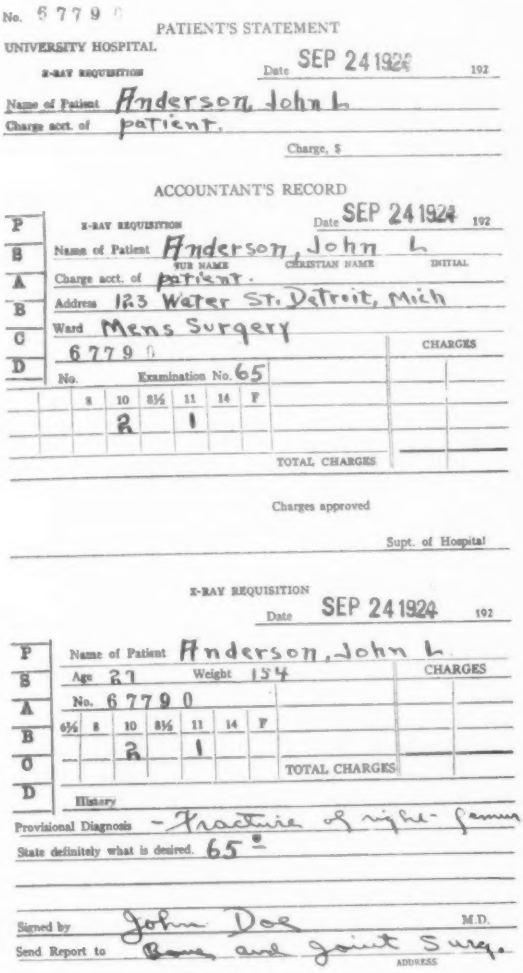
A CODE system for cross indexing records of patients was devised by the late Dr. James G. Van Zwaluwenburg of the Department of Roentgenology, University of Michigan Hospital. This system is still in use there and has been carried to several other institutions by men trained under him and subsequently by those trained by his successor.

The system to be described in this article was planned to take care of existing conditions as efficiently as possible with the aid of the clerical force then employed.

Practically every well organized roentgen department has its own routine method of registering patients and of filing reports and films. This is usually either part of the regular system of that particular hospital or office, or has been adapted to meet local conditions. However, most of the laboratories now using this particular cross index system have adopted the entire "paper work" making up the combination, although such a procedure is not necessary, as the cross index can be used alone.

A large number of institutions require a yearly report to be submitted, showing in detail the work done by each of the departments. To prepare such a report usually requires a great deal of work on the part of the clerical force. In teaching institutions where considerable lantern slide work is done, unless reductions are made before films and records are filed, oftentimes many favorable cases are lost. Then too, cases of like or contrasting nature are desirable for demonstration purposes and lectures. Likewise, members of the staff of other departments in preparation of papers or lectures, often call upon the roentgen department for slides, films, diagnosis or any other data in certain types of cases. To meet such existing conditions, Dr. Van Zwaluwenburg installed his cross index registering and filing system.

The requisition blank (Fig. 1) consists of a sheet of paper divided by perforations into three separate parts. The upper portion is used as a receipt, the middle



No. 6779 0

PATIENT'S STATEMENT

UNIVERSITY HOSPITAL

X-RAY REQUISITION Date SEP 24 1924 192

Name of Patient Anderson, John L

Charge acct. of patient.

Charge, $

ACCOUNTANT'S RECORD

P S A B C D X-RAY REQUISITION Date SEP 24 1924 192

Name of Patient Anderson, John L (SUR NAME / CHRISTIAN NAME / INITIAL)

Charge acct. of patient.

Address 123 Water St. Detroit, Mich

Ward Mens Surgery

6779 0 CHARGES

No. Examination No. 65

8	10	8½	11	14	F		
	2		1				

TOTAL CHARGES

Charges approved

Supt. of Hospital

X-RAY REQUISITION Date SEP 24 1924 192

P S A B C D Name of Patient Anderson, John L

Age 27 Weight 154 CHARGES

No. 6779 0

6½	8	10	8½	11	14	F		
		2		1				

TOTAL CHARGES

History

Provisional Diagnosis - Fracture of right femur.

State definitely what is desired. 65

Signed by John Doe M.D.

Send Report to Bone and Joint Surg. ADDRESS

FIG. 1. Requisition blank. Upper portion to patient for receipt, middle part to business office and lower part filed with patient's record.

part as the accountant's record in the business office, and the lower slip as part of the information relative to the patient

and is filed with the record of that individual. All records are filed in separate envelopes, alphabetically according to name. Additional data are added to the face of the envelope whenever the patient has a new examination (Fig. 2).

All departments are furnished a supply of requisition blanks and in addition, a list of examination numbers (Fig. 3). Examinations are requested by number with whatever additional notes the referring physician may deem it advisable to add.

When the patient and requisition reach the roentgen department, the clerk there ascertains whether or not the patient has an old record in the department. If so, this record is removed from the alphabetical files in order that it may be given a new number, in addition to those it may already have, this number corresponding to the one given to the new requisition.

Various data are now entered on the "day sheet" (Fig. 4) in the line with the name and number of the patient. Each new or return patient receives the next successive serial number following the last admission and the last two digits of this number are used as a plate marker. One hundred tags numbering from 00 to 99 are used as plate markers, the tag showing the last two digits of the serial number on the request accompanying it to the roentgenographic room. When the examination is completed, the technician makes note, in the alloted space, of the number and size of the films used. This is for the information of the clerk when making out the record envelope and the film labels (Fig. 5).

The reading file contains one hundred folders with numbers 00 to 99, that is, corresponding to the plate markers, and in these folders are placed the films after they are dry and labelled with a sticker showing the entire serial number. The film files are numerical and correspond to the serial numbers given the patients. When a patient is a return, all of the former films of that individual are taken from the film files and a dummy card (Fig. 6) left in their place. This form is also used as a memorandum receipt when films are removed from the files for any purpose. The old films are given the same serial number as the new films and are placed in the folder with the new films so that when a reading of the latter is made they may be used for comparison or reference. In this same folder, as additional information, is placed the lower portion of the requisition and old record envelope if the patient has one.

When the films are read and a diagnosis made, a code is given which designates the pathology and anatomical location of the

Name ANDERSON, JOHN L.

Date	Ex	8	10	11	14		F	Physician	No.
JAN 13 1923	64	2	1					Doe	51782
SEP 24 1924	65		2	1				Doe	67790

Diagnosis 612 - 01 623- FA

FIG. 2. Patient's record envelope. These are filed alphabetically and contain all reports and correspondence relative to that individual. The data shown on the face of the envelope are taken from the requisition and report of films.

lesion. All reports are made in duplicate, the original for the referring physician, and the duplicate for departmental files. The code is inserted by the stenographer in the lower left hand corner of the report and from there copied on the lower left hand corner of the record envelope.

This cross index system of symbols is somewhat similar to the decimal filing system, but uses letters instead of the decimal part of the fraction. As stated before, examinations are requested by numbers which divide the skeleton into certain numerical sections, i.e. 10–20 the head, 60–70 the lower extremities, etc. Now the anatomical portion of the code takes as a basis this division but increases it one digit, making hundreds instead of tens for the main division, but further subdivides the anatomical sections.

LIST OF X-RAY EXAMINATIONS

Note: This schedule is for the use of the Medical staff of the Hospital for information in ordering x-ray examinations. Under no circumstances should the schedule of prices be discussed with patients. Should a patient wish to make any special financial arrangement he should be referred to the main office. Please order by number to avoid confusion and misunderstanding. Additional instructions may be given in the space provided for that purpose.

	Schedule
10— Head, General,	g
11—Lateral Head,	f
12—Sella and base,	f
13—Accessory sinuses	e
14—Mastoids,	e
15—Teeth,	h
16—Sweet Localization,	c
17—Jaw,	d
20— Spine, General,	g
21—Cervical Spine,	e
22—Dorsal Spine,	f
23—Lumbosacral Spine,	f
30— Thorax,	
31—Thoracic Viscera,	f
32—Orthodiagram,	b
33—Thoracic Parites,	f
34—Oesophagus, Opaque meal,	d
40— Abdomen,	
41—Barium by the mouth,	g
42—Barium per anum,	f
43—Fluorescopic, forn. body,	b
44—Pneumoperitoneum, gen.	f
45—Pneumoperitoneum, pelvic,	e
46—Injection of sinus tract,	f
50— Upper extremity, General,	f
51—Hand,	d
52—Wrist,	d
53—Forearm,	d
54—Elbow,	d
55—Humerus,	d
56—Shoulder,	d
57—Clavicle,	d
60— Lower extremity, General,	g
61—Foot,	e
62—Ankle,	e
63—Leg,	e
64—Knee,	e
65—Femur,	e
66—Hip,	e
67—Pelvis,	f
68—Both Hips,	f
70— G-U tract,	
71—G-U tract for stone,	f
72—G-U tract, opaque inject,	f
73—Combined 71 and 72,	g
80— Treatment,	a
90— Photograph,	

FIG. 3. List of examination numbers to be used by referring physician to designate part to be examined.

For example examination #13—sinuses, is subdivided in the codes into 132—maxillary, 134—ethmoid, etc.

The lettered portion of the diagnostic code was made up primarily of an alphabetical index of diagnoses and by taking the first letter of each word, as for example:

Lues, joint, Charcot..... LJC
Neoplasm, carcinoma, metastasis. NCM
Tuberculosis, pulmonary, healed.. TPH

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Neoplasm, carcinoma, metastasis. NCM
Tuberculosis, pulmonary, healed.. TPH

Wherever possible this plan was carried out, but as additions and corrections had to be made until the code was complete and as etiology had to be considered in differentiating conditions, some of the code does not strictly follow this rule. Each letter of the alphabet is used for subdividing the conditions, adhering as closely as possible to the alphabetical index rule.

Two index card drawers are maintained for the current files. One drawer contains guide cards of all the numerical subdivisions of the body, the other drawer, guide cards of the diagnostic letter code (Fig. 7). After the report is rendered, a record envelope is made up, unless patient has an old record. The necessary data for this record envelope are obtained from the lower portion of the requisition and the code shown on the detailed typewritten description of the films.

DATE 192

| NAME | | |

that especial technique, viz., JBO-barium by mouth, JC-collargol injection, etc. A gastrointestinal examination which resulted in the diagnosis of a carcinoma of the pyloric end of the stomach would be coded as follows—JBO 412.NC.

Conditions which have no especial lettered code are classified as "miscellaneous" and receive the letter M and the diagnosis. Separate cards are used for these diagnoses under the guide M. Examples—626-M (bunion), 6241-M (Schlatter's Disease). These codes would be indexed on the numerical cards as usual but one would be placed on the bunion card under the M guide, the other under the same guide letter but on the Schlatter's disease card.

This system if properly used will be found very efficient and will give the office an alphabetical file of the complete record

FIG. 7. Index card drawers of current cases. Guide cards in these drawers show numerical and letter code symbols.

of all patients, a numerical file of films and a cross index of diagnoses, both pathologically and anatomically.

A few examples show the many uses of this system. Assume that it is necessary to have several cases of carcinoma of the G-I tract. Under the guide card 360 the cases showing NC may be used, and perhaps one 360-ZP selected as a point in differential diagnosis. These will show the lesion in the esophagus. Under guide cards 411-412-413 the desirable NC cases can be selected for showing the lesion in the different portions of the stomach. In the same manner cases in the large bowel may also be found. The serial number of the case shown on the index card facilitates the removal of the films. They are of course refiled according to number or a dummy card left in their place. Again assume a report is desired to show the number of cases of foreign bodies in the eye which have been examined during a certain interval. Obviously the number of cases

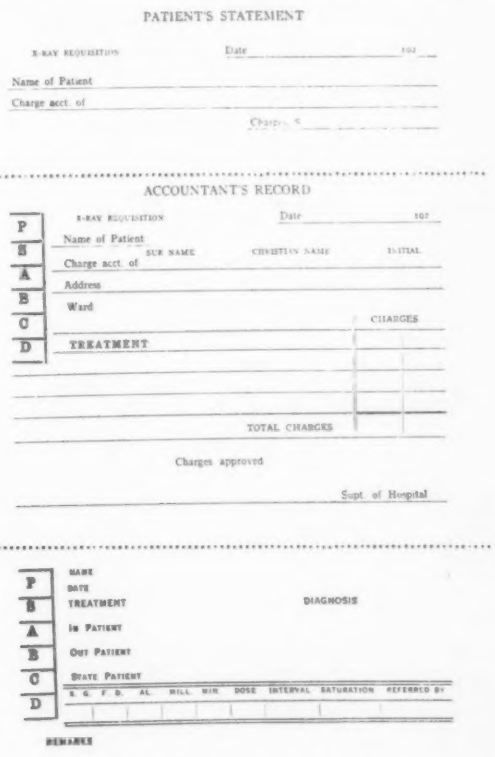


FIG. 8. Treatment, requisition.

coded BEE during that interval of time on cards under the 160 guide will give the answer.

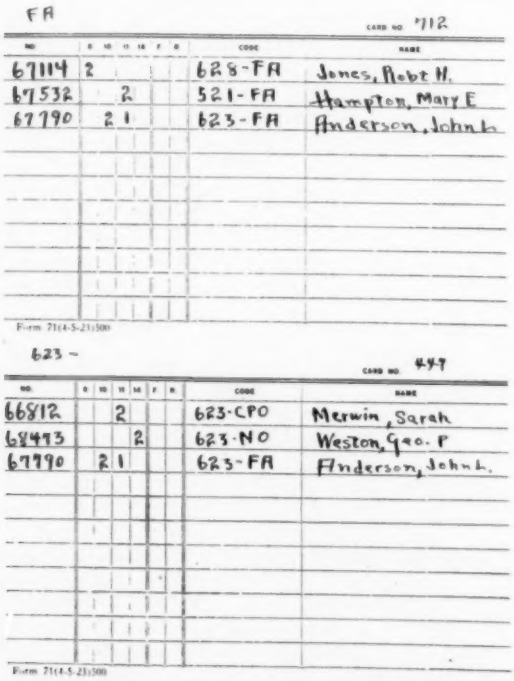
In regard to treatment cases, practically the same system of registration by serial number is followed, except the lower portion of the requisition is so constructed that the technique used can be noted, the other two portions of the requisition being the same (Fig. 8).

The cross index code for such cases uses the same numerical subdivisions for areas treated. At times, until a complete code is made up, it may be found necessary to add numbers to designate the area, merely increasing the number of guide cards for new areas. The diagnostic code is made up

in the same manner as the roentgenographic diagnostic code, that is by indexing the conditions and by taking the first letter of each word. Neoplasms would of course fall under the heading of N the same as in the diagnostic letter division, i.e.

Neoplasm, sarcoma	NS
Neoplasm, epithelioma	NE
Neoplasm, Hodgkin's	NH
Neoplasm, lymphosarcoma	NLS
Pruritis, ani	PA
Pruritis, vulvae	PV
Thyroid, exophthalmic	TE
Verrucae, palmar	VPA
Verrucae, plantar	VPL

The above are only samples and show that one can construct his own code or make additions and in that way be more familiar with the symbols.


FA

CARD NO. 712

NO.	CODE	NAME
67114	628-FA	Jones, Robt H.
67532	521-FA	Hampton, Mary E
67790	623-FA	Anderson, John L

Form 7114-5-21-500

623 –

CARD NO. 447

NO.	CODE	NAME
66812	623-CPO	Merwin, Sarah
68493	623-NO	Weston, Geo. P
67790	623-FA	Anderson, John L.

Form 7114-5-21-500

FIG. 9. Cards used for cross indexing records.

To one who is familiar with this system of keeping records and with using it every day it presents untold possibilities. Information concerning cases is always available on short notice, thereby increasing the efficiency of the office, and although it presents the problem of some increase in clerical work, the return for this labor is a set of records in which every individual in the department takes pride.

The following code is the one now in use:

100—HEAD
110—Calvarium
120—Base
121—Sella turcica
130—Sinuses
132—Maxillary
133—Sphenoid
134—Ethmoids
135—Frontals
140—Ear and mastoid
150—Teeth
160—Eye
170—Jaw
180—Nasopharynx
190—Pineal gland
191—Small bones of the face

200—NECK
210—Cervical spine
220—Cervical ribs
230—Thyroid
240—Lymph glands of the neck

300—CHEST

310—Lungs
311—Parenchyma
312—Pleura
313—Bronchi
314—Trachea
315—Larynx
316—Thymus
317—Diaphragm

320—HEART

321—Myocardium
322—Pericardium
3231—Aortic valve
3232—Mitral valve
3233—Pulmonary valve
3234—Tricuspid valve
323—Valvular disease
324—Aorta
325—Orthodiagram
330—Mediastinum
340—Ribs
350—Sternum
360—Esophagus
370—Dorsal spine

400—ABDOMEN

401—Peritoneum
410—Stomach
411—Cardia
412—Pars media
413—Pylorus
420—Duodenum
421—Upper small bowel
422—Lower small bowel
430—Colon
431—Cecum
432—Ascending colon
433—Transverse
434—Descending
435—Sigmoid
436—Liver
437—Appendix
438—Spleen
439—Omentum
440—Gall-bladder
450—Pancreas
460—Kidney tract
461—Kidney cortex
462—Kidney pelvis
463—Ureter
464—Urinary bladder
465—Urethra
466—Prostate
467—Rectum
470—Lumbar spine
475—Lumbosacral articulation
480—Sacrum
485—Sacroiliac articulation
490—Retroperitoneal structure

500—SHOULDER AND ARM

510—Joints
511—Shoulder
512—Elbow
513—Wrist joint
514—Fingers
515—Bones of the wrist
520—Bones of the arm
521—Clavicle
522—Scapula
523—Humerus
524—Bones of the forearm
5241—Ulna
5242—Radius
525—Bones of the hand
526—Metacarpal
527—Phalangeal

600—PELVIS AND LEG

610—Joints
611—Hip
612—Knee
613—Ankle
614—Small bones of the feet
617—Ischium
621—Pubis
622—Ilium
623—Femur
624—Leg bones
6241—Tibia
6242—Fibula
6231—Patella
625—Bones of the tarsus
626—Metatarsal
627—Phalangeal

628—Os calcis
700—Experimental cases series

800—PELVIS

801—Pelvic peritoneum

802—Pelvic tumor
803—Pelvic procidentia
804—Pregnancy
810—Uterus
811—Isthmus of uterus

812—Fundus of uterus
820—Tubes
830—Ovaries
840—Broad ligaments

DIAGNOSTIC CODE

A-A—Anomalies
AL—Sacralization of the lumbar spine
AP—Pes planus (flat foot)
AZ—Spina bifida

BB—Foreign body
BA—Bony ankylosis
BC—Calculus
BCG—Biliary
BCR—Urinary
BCS—Salivary
BE—Extraneous
BEE—In the eye
BEO—In the esophagus
BET—In the trachea
BEU—Unclassified
BM—Joint mice
BP—Psammoma
BCP—Prostatic calculi
CC—Inflammations
CA—Atrophic arthritis
CAD—Arthritis deformans
CAP—Chronic appendicitis
CAPL—Mesenteric lymphoid hyperplasia
CAV—Villous arthritis
CD—Dry or fibrous
CF—With fibrous
CFJ—Ankylosis
CS—Congestion
CH—Hypertrophic
CHT—Traumatic arthritis
CI—Infectious arthritis
CLS—Lumbosacral arthritis
CO—Inflammatory osteophytes
CP—Purulent
CPA—Purulent arthritis
CPB—Chronic bronchitis
CPC—Croupous pneumonia
CPE—Empyema
CPG—Gall-bladder disease
CPD—Polypoid degeneration
CPL—Broncho-pneumonia
CPM—Mastoiditis
CPME—Otitis media
CPO—Osteomyelitis
CPP—Pyelonephritis
CPS—Accessory sinusitis
CPU—Unclassified
CPV—Pelvic inflammatory
CSA—Serous arthritis
CS—Serous inflammations
CSC—Pericardial effusion
CSM—Asthma
CSP—Pleurisy with effusion
CSR—Spondylitis rhizomelique
CSU—Unclassified
CPZ—Emphysema
CPR—Pleurisy
CU—Peritonitis

DD—Dislocations
DC—Congenital dislocations
DR—Dislocations reduced
DT—Traumatic dislocation

FF—Fractures
FA—Simple
FC—Comminuted
FD—Fracture dislocation
FE—Epiphyseal
FF—Infected
FG—Greenstick
FI—Impacted
FM—Compound fracture
FL—Plated fracture
FP—Pott's fracture
FS—Spontaneous
FTC—Torn cartilage
FU—Unclassified
FW—Colles' fracture
FH—Healed fracture

GE—Gastroenterostomy
GR—Gastric retention
GS—Intestinal stasis
GJ—"Jejunal dyspepsia"

HH—Hemorrhage

IS—Iliac stasis

JJ—Injections
JB—Bismuth or barium
JBA—per anus (barium enema)
JBO—By mouth (barium meal)
JBS—Injection of sinus tract, paste
JC—Collargol
JT—Thorium
JG—Gas (oxygen) injection
JL—Lipiodol

KK—Pneumoperitoneum (gynecological)
KA—Anomaly
KCF—Adhesions
KCI—Acute inflammation
KCP—Purulent collection
KCS—Serous exudate
KCU—Unclassified inflammations
KDD—Downward displacements
KDL—Lateral displacements
KDU—Upward displacements
KH—Enlargement
KNC—Carcinoma
KNF—Fibroid
KNS—Cyst
KNU—Unclassified
KOD—Operative defect
KP—Pregnancy
KPT—Twin pregnancy
KSA—Senile atrophy

LL—Syphilis
LB—Bone syphilis
LC—Congenital syphilis
LJ—Joint syphilis
LP—Syphilitic periostitis
LJC—Charcot joint

MM—Miscellaneous
MA—Acromegaly
MG—Goldthwaite's disease
MIS—Iliolumbar strain
MH—Myocardial hypertrophy
MW—Myocardial weakness
MP—Perthes' disease

NN—New growths
NC—Carcinoma
NCM—Metastatic carcinoma
NE—Enchondroma
NF—Fibroma
NFC—Osteitis fibrosa (cystica)
NH—Hypernephroma
NO—Osteoma
NS—Sarcoma
NU—Unclassified
NOM—Ossifying myositis

O—Edema
P—Pneumo
PM—Pneumonia,—post
PS—Surgical pneumothorax
PO—Post-operative
PE—Senile emphysema
PMH—Pneumonia, healed

Q—Tooth conditions
QA—Root abscess
QB—Pulp stone
QC—Dental caries
QF—Films to dentist without comment
QI—Impacted
QL—Unerupted
QR—Fractured tooth
QU—Unclassified
QP—Pyorrhea alveolaris
QS—Perforation
QZ—Root fragment

R—Rickets

S—Diagnosis impossible

T—Tuberculosis
TB—Bone tuberculosis
TBP—Pott's disease
TG—tbc bronchial glands
TJ—Joint tuberculosis
TL—Tuberculous adenitis
TP—Pulmonary tuberculosis
TPC—Cavitation
TPF—Fibroid changes
TPI—Infiltration
TPH—Healed tuberculosis
TPM—Miliary tuberculosis
TPU—Unclassified pulmonary
TS—Sinovitis
TU—Tuberculosis unclassified
TIP—Intervetebral Pott's
TPA—Apical cap (Van Zwaluwenburg line)

W—Peptic ulcer
WD—Duodenal ulcer
WG—Gastric ulcer
WP—Pyloric ulcer

X—Negative

XI—Extraordinary interest
XS—Anatomical study

V—Vessels
VA—Arteriosclerosis (atheroma)
VH—Vascular hypertension
VI—Valvular insufficiency
VS—Valvular stenosis

Z—Late effect, sequelae, and reflex results
ZA—Atrophy
ZAN—Neurotrophic atrophy
ZB—Sclerosis
ZC—Coxa vara
ZD—Dilatation
ZDB—Bronchiectasis
ZDN—Hydronephrosis
ZE—Coxa valga
ZF—Fibrosis
ZH—Hypertrophy
ZI—Ileocecal incompetency
ZJ—Fistula
ZL—Phleboliths
ZM—Soft tissue injury
ZN—Neurosis
ZO—Osteoporosis
ZP—Spasm
ZQ—Sequestrum
ZR—Stricture
ZS—Scoliosis
ZT—Ptosis
ZU—Obstruction
ZV—Diverticulum
ZW—Surgical defect
ZX—Calcifications
ZZ—Adhesions.

A METHOD OF PROTECTION FOR ROENTGENOSCOPIC WORK

BY C. HARVEY JEWETT, M.D.

Clifton Springs Sanitarium

CLIFTON SPRINGS, NEW YORK

THE apparatus described here is a substitute for the usual heavy lead apron worn by the roentgenoscopic operator and is believed by the author to be more convenient and to afford better protection.

The apparatus as described is adapted for use in either the horizontal or vertical position and can be easily raised out of the way when not in use. It consists of two heavy lead rubber curtains suspended from pulleys in the ceiling and counterbalanced on the other end by means of ordinary window weights. These weights are suspended out of sight in long boxes on the side wall and the curtains are so balanced that they will stay in any position and can be moved up and down to correspond with the position of the screen.

The material used is $\frac{1}{8}$ inch lead rubber which affords better protection than the ordinary apron. The apparatus can be easily adapted to any situation and is simple and inexpensive to construct.

FIG. 1. Shows the roentgenoscope in the vertical position with the lead rubber curtain down.

FIG. 2. Shows the roentgenoscope in the vertical position with both curtains raised. Arrows indicate the boxes containing window weights.

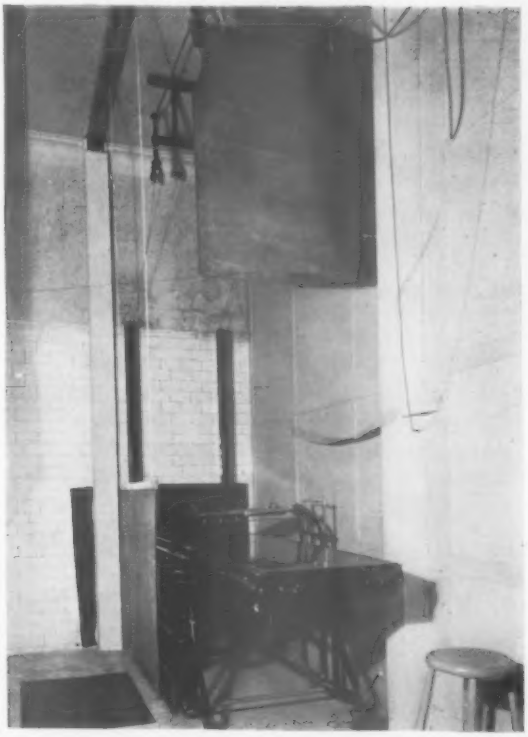


FIG. 3. Shows the roentgenoscope in the horizontal position with the lead rubber curtain lowered at the side, and the vertical curtain raised.

BOOK REVIEWS

Books Received Are Acknowledged under Heading: Books Received. This must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers and as space permits.

A DICTIONARY OF TREATMENT. By Sir William Whitla, M.D., D.SC., LL.D., M.P. Emeritus Professor of Materia Medica and Therapeutics in Queen's University, Hon. Physician in Ordinary to H. M. The King in Ireland, Consulting Physician to Royal Victoria, Belfast Ophthalmic, and the Ulster Hospitals for Women and Children. Seventh edition. Cloth. Price, $10.00. Pp. 1100. New York: Paul B. Hoeber, Inc., 1924.

When any book has reached a seventh edition and a distribution of over thirty-eight thousand volumes, it must be a worth while publication. Such is the successful record of Whitla's Dictionary of Treatment, which includes medical and surgical therapeutic suggestions in alphabetical sequence. There are eleven hundred pages of splendid, legible typography with an excellent cross index at the end of the volume.

Although the original edition was published in 1891, we find this latest 1924 seventh edition is strictly up to the minute in therapeutic suggestions of modern innovations in medicine. Mr. S. T. Irwin, surgeon to the Royal Victoria Hospital, is responsible for the revision of surgical sections and Professor R. J. Johnstone, the gynaecological sections.

Quite naturally, each subject is treated briefly, but there is a nice judgment and balance displayed. Relative importance of subjects has received studied attention.

Radiologists will look with favor upon the generous disposition of Whitla to give their specialty a fair share. This is especially noticeable in the three pages devoted to uterine fibroids. We quote: "While the views (surgical) just put forward are undoubtedly those of the majority of gynaecological surgeons, it is but fair to say that within the past few years a very large amount of work has been done in the treatment of fibroid tumors by *x*-rays and by radium, and the results already reported are so encouraging that the day seems almost to have arrived when, in cases suffering from uterine fibroids, a choice will have to be made between operation and radiotherapy. This is especially the case in patients whose main symptom is haemorrhage. The rationale of radiotherapy is partly the destructive effect of the rays on the ovaries, causing a premature menopause, and partly direct action on the tumour elements, causing shrinkage of the growth. Although a number of cases have been reported in which the action of the rays was so nicely graduated that a menorrhagia gave place to normal menstruation, instead of an amenorrhoea, it seems to be generally admitted that the most suitable cases for radiology are those which are already approaching the menopause, and that cases of submucous or gangrenous fibroids, and those in which inflammatory lesions such as pyosalpinx complicate the case, are unsuitable for the method."

Throughout this dictionary of treatment one notes the same careful estimation of values. It is more than a mere catalogue of remedies for diseases because the author and his associates draw upon their years of experience in telling the reader the best accredited methods and therapy advisable under each diagnostic heading.

Mr. Hoeber has secured the American rights for this publication. We believe that it will achieve the success here that it has enjoyed in England and her colonies.

E. H. SKINNER.

GRENZEN DES NORMALEN UND ANFÄNGE DES PATHOLOGISCHEN IM RÖNTGENBILDE. von Prof. Dr. Alban Köhler, Facharzt für Röntgenologie in Wiesbaden. Fourth edition. Paper. Price, $5.80. Pp. 441, with 242 text figures. Hamburg: Lucas Gräfe and Sillem, 1924.

"To physicians who are just beginners in the science of roentgenology or who do not command an extensive experience, this volume is a guide in the interpretation of roentgenologic findings which present or appear to present slight, scarcely perceptible deviations from the known normal anatomical pictures."

The present (fourth) edition appears within two years after the third with numerous additions to the text and illustrations. The chapter on the duodenum and the sections on the stomach, heart, jejunum and ileum, liver and foot have been completely revised. For various reasons the author has not as yet seen fit to include in this work the results obtained by indirect diagnostic methods such as oxygen insufflation of joints, pyelography and pneumography of the urinary system, of pneumoperitoneum and pneumocranium.

The author makes clear that this volume is not a text for study, but is intended solely as a reference work. The first chapter is a general one treating of the bones, cartilages and joint

capsules, followed by a discussion of the soft and parenchymatous tissues. The special section, comprising the major portion of the book, treats systematically of the extremities, the spine and head. This is followed by a systematic treatment of the soft tissues beginning with the neck and ending with the pelvic organs. The author makes quite clear that there is no intention to regard the roentgen findings as the sole diagnostic sign. He states, "Behind every statement in this book one must keep in mind the proviso: provided the anamnesis and the clinical findings favor, or at least do not oppose this statement."

The text is profusely illustrated with line drawings that are well executed. The arrangement of the subjects, the table of contents and the index all combine to make the material contained in this volume readily available for reference purposes. The author furnishes in many cases references to papers in which the particular subject is treated authoritatively. The fact that there are included in this volume references to the American Journal of Roentgenology of the latter part of 1923 shows that Professor Köhler has included most recent available material in this reference work.

BARNETT COHEN.

BOOKS RECEIVED

DIE HYPEROSTOSEN DES SCHÄDELS. Von Dr. Inasaburo Naito, mit einem vorwort von Professor Dr. Artur Schüller. Cloth. Price, $3.25, Pp. 95, with 95 illustrations. Wien and Leipzig: Josef Safar, 1924.

DENTAL DRAWING. By Edward Drosen, D. D. S., Head, Department of Dental Drawing, Marquette University College of Dentistry. Cloth. With illustrations and 22 full page plates from original drawings by the author. Brooklyn, N. Y.: Dental Items of Interest Publishing Co.; London: Claudius Ash, Sons and Co., 1924.

AMERICAN ANNUAL OF PHOTOGRAPHY 1925. Volume xxxix, Edited by Percy Y. Howe. Paper. Price $1.75. Cloth. Price, $2.50 New York: The American Annual of Photography, Inc., 1924. Sales agents, George Murphy, Inc., 57 East 9th St.

GRENZEN DES NORMALEN UND ANFÄNGE DES PATHOLOGISCHEN IM RONTGENBIDE. Von Prof. Dr. Alban Köhler, Facharzt für Röntgenologie in Wiesbaden. Fourth edition. Paper. Price, $5 80. Pp. 441, with 242 text figures. Hamburg: Lucas Gräfe and Sillem, 1924.

INTERNATIONAL ABSTRACTS OF ROENTGEN AND RADIUM LITERATURE

ROENTGEN DIAGNOSIS

BOWEN, ALBERT. Myositis ossificans in the army following horseback injuries to the thigh. *Arch. Surg.*, November, 1924, ix, 619–635.

Two cases are described occurring in army officers receiving injuries on the thigh during horseback riding. A questionnaire sent to surgeons of cavalry regiments in the United States Army disclosed that this condition is rather uncommon in our mounted troops. As to the etiology of this condition, one of the cases had apparently a diathesis which had already produced an overgrowth of bone in the knees. Then came the severe trauma probably tearing off some periosteum with underlying osteoblasts, hemorrhage, and pulpifying of muscle into which the osteoblasts were planted; and on account of the bony diathesis these proceeded to form a bony tumor in the muscle. There are so many similar injuries in which ossification does not occur that one is almost forced to the conclusion that there is some determining factor in addition to the trauma.

The principal problem in diagnosis is to rule out sarcoma and not to treat this benign lesion as malignant. A good roentgenogram will usually enable the diagnosis to be made. When in doubt an exploratory excision for diagnosis is permissible. When the roentgenogram shows a clear zone between the shaft and the dark area of bone formation in the soft parts and this dark area is distinctly that of osseous tissue, sarcoma can be excluded. Most cases of ossifying myositis show in the roentgenogram a zone of bone formation in the soft parts with a clear zone between it and the neighboring bone of the skeleton. The size, shape and markings of the shadow of the new bone formation are so characteristic that the benign lesion can be recognized in the roentgenogram.

CHRISTIAN, HENRY A. Some observations, largely pessimistic, on the early diagnosis of gastric cancer. *J. Am. M. Ass.*, June 21, 1924, lxxxii, 2011–2013.

A review representing clinical experience of twenty years of active hospital work leaves the impression with the author that the early diagnosis of cancer of the stomach, in the sense of recognizing it in the stage when it is small locally and before it has metastatized, is still almost an impossibility with the present available methods. Furthermore, results of roentgen-ray examination of the stomach in cases whose general study points to a functional gastric disturbance hardly justify the examinations from the point of view of the recognition of unexpected cancer. Their value lies in their positive usefulness in the recognition of ulcer and their help in the diagnosis of gall-bladder disease. In these the value is great enough to fully justify the procedure, but the procedure does not lead to finding unexpected cancers of the stomach.

HENDERSON, MELVIN S., AND SIMON, HAROLD E. Brodie's abscess. *Arch. Surg.*, November, 1924, ix, 504–515.

Brodie's abscess is a chronic infection in the cancellous tissue at the extremities of the long bones, manifesting itself as a well localized pyogenic abscess, usually without external fistula or sequestrum. It is a focus of infection situated in the spongy portion of the long bones near the epiphyseal line, arising either as a remnant of a former osteomyelitis or of unexplained origin. There is often a period of latency, or the disease may burst into activity as a result of lowered resistance. The occasional complications are sinus formation with sequestrum, extension into the diaphysis, an effect on the general health, and marked enlargement. Surgical treatment results in cure in a majority of cases, although recurrence is occasionally found.

The roentgen-ray findings of this disease are characteristic. There is an increase in the diameter of the bone, gradually fading off to the normal, periosteal thickening. There is often sclerosis of the cancellous bone and usually a sharply outlined cavity showing up as a rarefaction of from 2 to 4 cm. in diameter. If such sclerosis is very extensive, it may obscure the area of rarefaction and make the diagnosis more difficult.

FOSSIER, A. E. Size of the normal heart. *J. Am. M. Ass.*, June 21, 1924, lxxxii, 2016–2021.

A consideration of the subject leads to the conclusion that roentgenology has not furnished an adequate basis for determination of the normality of the heart's size, and that percussion is of greater value in delimiting the cardiac area. An illustration is given of the dropped heart in a tall man with marked visceroptosis. The percussion and roentgen-ray outlines practically coincided in size and shape

with some difference in position of the heart due to respiratory changes. The interesting features were the absence of pulsation at the apex and a marked diffused pulsation below the ensiform cartilages, and the fact that because of extreme vertical position of the heart there was only one line of dullness corresponding to the roentgen-ray outline. This is characteristic of a dropped heart, the difference between the two lines of dullness diminishing as the vertical position of the heart is increased. A longitudinal diameter of 11.7 cm. as compared with the transverse diameter of 9.5 cm. is characteristic of the markedly dropped heart. In other roentgenograms the size of the heart is exaggerated in both the percussion and roentgen-ray outlines. This exaggeration is variable, for while it is practically negligible in the vertical heart it increases considerably with increase in obliqueness of position.

The correlation of the normal sized heart and the fist of the individual is constant and is the only practical determinator of the normal heart size. The linear dimension of the transverse diameter of the heart corresponds to a line drawn from the junction of the inner side of the right hand and the wrist and ending at the middle joint of the fourth finger (the ring finger).

KOLODNY, ANATOLE. A case of primary multiple endothelioma of bone. *Arch. Surg.*, November, 1924, ix, 636–646.

A description is given of a rather rare case of bone tumor interpreted as a primary multiple endothelioma of the skeleton, occurring in a woman aged forty-eight. The roentgenograms showed the existence of a tumor considered malignant because of its multiplicity, its non-periosteal origin and the age of the patient. Primary sarcoma was excluded on the basis of the multiple character alone. The nonmedullary location of the tumor, the absence of diffuse absorption of bone and the presence of new bone formation were against a diagnosis of multiple myeloma. The tumors were distinctly limited and the shaft of the fibula showed nothing but a readily explainable atrophy of bone. Carcinoma seldom invades the appendicular skeleton without previous or additional involvement of the axial skeleton; but in the present case the tuber ischii was involved during a period of eight months while the dorsal and lumbar vertebrae showed no roentgenologic evidence of involvement. The presence of large osseous tumors in the involved bones also spoke against carcinoma. The roentgenologic features in the 3 cases of primary endothelioma of bone which have been studied roentgenologically to date all agree as to the presence of definite bone production in this condition. This new bone throws a shadow less dense but of larger size because the amount of bone tissue is not less and indeed may be even more than before involvement. Roentgenologic study seems indispensable in the determination of bone destruction or production in more or less extensive bone tumors.

KRETSCHMER, HERMAN L. Carcinoma of the kidney. *Arch. Surg.*, September, 1924, ix, 284–292.

A description is given of 4 cases which illustrate the value of complete, careful and accurate study in all cases of renal hematuria, especially when the hematuria is painless and symptomless. By the aid of pyelography, tumors of the kidney may be easily and accuately diagnosed even though the tumors be small. It is pointed out that tumors may be overlooked and their existence remain unsuspected because of the presence of some other obvious lesion such as a stone.

The first case was that of tumor of the kidney involving the region of the inferior calyx. Nephrectomy was performed and the diagnosis confirmed. The patient made an uneventful recovery. The patient died two years later of metastatic carcinoma of the second lumbar vertebra. In the second case the pyelogram of the right kidney showed a filling defect in the superior calyx. This was diagnosed as tumor of the kidney pelvis. A nephrectomy was performed and the patient made an uneventful recovery. Examination of the kidney showed in the upper pole of the pelvis a soft, polypoid, grayish-white tumor with a broad pedicle. In the third case there was a large kidney containing stones in the pelvis, and two small carcinomatous masses. In the fourth case roentgen-ray examination revealed a calculus in the left kidney. On operation the kidney was found surrounded by much fibrous tissue and was of enormous size. Section of the specimen disclosed a large hydronephrotic sac which on further examination revealed a tumor in the upper part. A similar papillary tumor was also found in the lower part of the kidney.

MACGUIRE, C. J., JR., AND MCWHORTER, J. E. Sarcoma of bone: An analysis of fifty cases. *Arch. Surg.*, November, 1924, ix, 545–592.

The cases discussed are confined to the group of osteogenic tumors of the malignant type, to giant cell tumors and Ewing's tumor (probably endothelioma). Through history and physical examination it should be possible in most cases to exclude syphilis, tuberculosis, metasta-

tic tumors and osteomyelitis. Correct differentiation depends upon roentgen-ray examination and pathologic section. It is essential, however, that the roentgenologist and the pathologist give an accurate description of the roentgenogram or the microscopic findings and do not confine themselves to a diagnosis.

From the roentgenogram the location of the bone tumor, whether it be central or periosteal, can be determined; and the presence or absence of a bony capsule, the invasion of the soft parts or of new bone formation can be detected. When the destructive process is slow enough to permit the formation of an expanding bony capsule, the prognosis is correspondingly improved. There is a rather characteristic picture in many giant cell tumors where the lesion shows an irregular trabeculated formation of cortical bone somewhat similar to polycystic disease. These formations are almost always located in one of three places, at the head of the tibia, at the lower end of the femur, or at the lower end of the radius, extending to but not through the cartilage. Ewing has found a characteristic roentgen-ray picture in diffuse solitary endothelioma of the bone.

It is strongly urged that routine tissue section should be removed in all cases of suspected bone tumor. The only contraindication is the spreading of metastases, which it is believed occurs only in the hopelessly malignant type. After consideration of the clinical, roentgen-ray and pathologic findings, one should be able to arrive at a diagnosis of sarcoma in all cases, and in about 90 per cent of them be able to distinguish between osteogenic, giant cell and round cell or endothelial tumors. Further differentiation is bound to be arbitrary.

STENHOUSE, H. M. Gastrojejunocolic fistula. *J. Am. M. Ass.*, June 14, 1924, lxxxii, 1926–1927.

A not uncommon result of gastroenterostomy is the fixation of the transverse colon near the anastomosis. If the cause of the original ulceration is not removed, new ulcers may occur in spite of drainage of the gastric contents provided for by the operation. The outcome of such an ulcer perforating the walls of the jejunum and the colon at the site of fixation is a gastrojejunocolic fistula. If this condition is recognized early and treated promptly the chances for recovery are fair. A single roentgenogram of the colon will disclose the picture. This point is important because several roentgenograms made after bismuth meals and bismuth series gave utterly useless results in the case described. The latter occurred in a man, aged thirty-five, who was admitted with a diagnosis of chronic enteritis. He had had a gastroenterostomy performed eleven years previously. Symptoms of acute diarrhea were found to be due to fistula. The patient gradually weakened from lack of appetite and succumbed to starvation. Post-mortem examination showed the old anastomosis to be patent, with a small intestine that had ceased to function because of the short cut produced by subsequent ulceration and perforation.

STEWART, S. F. Absence of sacrum. *Arch. Surg.*, November, 1924, ix, 647–652.

Absence of the sacrum is an extremely rare condition, only 6 cases having been found recorded or referred to in the literature. The author gives a description of this abnormality in a boy aged six, who had no control of the bladder and bowels. The child had double club feet and some deformity in the region of the lower spine at the time of birth. Tenotomies were performed on the feet when the child was two days old and a mild correction obtained; otherwise he appeared normal physically and mentally.

The roentgen-ray examination revealed complete absence of the sacrum and coccyx. The ilia were articulated with the transverse processes on the fifth lumbar vertebra and apparently also with the spinous process. The pelvic inlet was much increased in transverse diameter and appeared to be oval in shape. The diagnosis of absent sacrum and coccyx, total incontinence and bilateral equinovarus was made.

As in many other developmental defects nothing is known of the cause and nothing has been suggested as to treatment. To the orthopedist, the almost universal association with equinovarus is worthy of note.

ALVAREZ, WALTER C., AND FREEDLANDER, B. L. The rate of progress of food residues through the bowel. *J. Am. M. Ass.*, Aug. 23, 1924, lxxxiii, 576–580.

The commonly accepted view that food residues from any one meal are evacuated within 24 or 48 hours is shown to be largely erroneous. Experiments are cited showing that the usual large amount of barium given with a small meal acts like agar or liquid petrolatum and speeds up the progress of material through the bowel.

In the study reported, 50 small glass beads were used as an index to the rate of progress of the everyday food of the individual. Ordinarily about 15 per cent of these beads are passed on the first day; 40 per cent on the second; 15 per cent on the third, and 10 per cent on the fourth day. After that it may take days or weeks before the last few beads are recovered. The rate of progress varies

widely in normal persons. No symptoms of disease were found in men and women who took a week or more to pass 70 per cent of the beads. High rates of excretion, that is 85 per cent in 24 hours are associated with the passage of soft, badly digested stools. Purgatives or spontaneous attacks of diarrhea empty the colon so thoroughly that often for one or two days afterwards there are no bowel movements, or else very small ones.

After a barium meal a quantitative analysis of the stools for barium shows that although most of it is excreted in the first 24 or 48 hours a considerable amount remains to come away slowly during the next few days. These observations must modify some of our views about intestinal autointoxication and the need for the frequent use of laxatives.

BERMAN, SAUL. Complete dislocation of tarsal scaphoid. *J. Am. M. Ass.*, July 19, 1924, lxxxiii, 181–183.

Dislocation of the tarsal scaphoid, a very rare occurrence, is described in a boy aged seventeen, who sustained the injury by having a horse fall upon his right foot. The roentgen-ray examination showed the scaphoid completely dislocated inward and backward toward the heel opposite the head of the astragalus. A fracture of the cuboid was also present.

A closed manual reduction was performed by plantar flexion, abduction and direct pressure on the scaphoid. Roentgen examination showed that a perfect reduction had been performed. The patient was able to walk without crutches in ten weeks, but complained of considerable pain when on his feet too long. A moderate amount of flatfoot followed. This can be prevented in part by giving support to the longitudinal arch during convalescence, and by prescribing exercises to strengthen the foot muscles.

DRUMMOND, HAMILTON. The diagnosis of malignant disease of the large intestine. *Brit. M. J.*, Aug. 16, 1924, No. 3320, 261–265.

Where a definite structure has to be located in the large intestine the opaque enema is the method of choice; and the opaque meal is to be employed where the function of the colon is to be thoroughly investigated. Although the use of barium enemas is regarded as a valuable method of examination it cannot be relied on alone. A growth producing partial obstruction may not necessarily interfere with the passage of the barium, as was evidenced in a case cited. In another case a most advanced cancer of the bowel existed and still permitted free passage of a barium enema.

It is difficult to exaggerate the value of palpating the barium-filled colon under the roentgen screen in the diagnosis of lesions of the large intestine. The colon stands out in a dense shadow and can be freely moved about the abdomen. When an abdominal tumor is present its exact relation to the colon can be detected, for the latter is easily altered in position in relation to the swelling so that it can be ascertained whether or not the tumor has its origin in the large gut. The method is useful chiefly in the case of tumors in the immediate neighborhood of the colon. Roentgenologists should not make a diagnosis on their findings alone.

PANCOAST, HENRY K. Importance of careful roentgen-ray investigations of apical chest tumors. *J. Am. M. Ass.*, Nov. 1, 1924, lxxxiii, 1407–1411.

An infiltrating growth of either endothelioma of the pleura or sarcoma, probably of bony origin, may occur in the apex of the thoracic cavity and produce a symptom-complex of pain in the upper extremity and cervical sympathetic paralysis closely simulating that of many other conditions, such as spinal cord or meningeal tumors, neck tumors, cervical rib and vertebral neoplasms. Roentgen-ray examinations of the shoulder alone before the appearance of eye manifestations may fail to reveal such a growth. Four cases are described, in 3 of which an early diagnosis of the condition was missed because of incomplete roentgenologic study or faulty interpretation of the roentgenogram. In the fourth case, no attention was paid to roentgenologic suspicions of the lesion present. In all 4 cases the roentgen-ray diagnosis was finally established.

The need for including a wider area in the roentgen-ray examination in obscure cases becomes evident. In such examinations of the spine and for cervical rib the roentgenograms should be carefully studied for any increased density in the apex of the lung, or for erosion of the upper ribs or adjacent vertebrae.

A fifth case is described in which a spindle cell sarcoma caused destruction of the third and fourth ribs posteriorly but was well away from the apical region. The growth showed externally on this patient. Had this tumor been located in the apical region it would probably have produced the same symptom-complex seen in the others.

WASSON, W. W. A roentgenographic study of the infant chest as seen at birth. *J. Am. M. Ass.*, Oct. 18, 1924, lxxxiii, 1240–1243.

It is possible and practical to roentgenograph an infant at any age and draw conclusions as to the processes taking place. By attention to necessary details, comparable roentgenograms may be made of the new-born.

In the still-born infant without respiration the roentgenogram shows uniform density throughout the chest, obliterating all the pulmonary structure as well as the heart. The shape of the chest in the still-born is that typical of the new-born with uniform density filling the entire thorax, the ribs forming an acute angle with the spine. With respiration, air is found to enter the lungs, the stomach and the intestines so that the roentgenogram begins to show evidence of lung structure along with changes in the shape of the chest. Appearance of full expansion may be obtained within five minutes after delivery; and again, especially in cases of prolonged difficult delivery, the lung expansion may be slow, leaving entire lobes atelectatic, or with scattered areas of atelectasis. The bases of the lungs seem to be the last to expand completely, the lateral borders being probably the first. No particular change was noticed in the shape or position of the diaphragm or the heart or its great vessels. There is marked change in the shape of the chest due to a change in the angle of the ribs.

In the fully expanded infant's lung the thorax is distinctly cylindrical in appearance with a slight but gradual slope of the ribs from apex to base. The right diaphragm is usually slightly higher than the left. The heart and mediastinum are not greatly different from those in the adult, but the left ventricle appears more prominent in the infant, and the great vessels less so. The trachea lies in the midline, bifurcating near the third thoracic vertebra and entering a well defined hilum on each side. The linear markings of the lung with their columns of air may be traced well to the periphery and are quite prominent, especially those upward toward the apex and downward toward the base. They are, on the whole, of uniform density with an occasional small area of increased density. The periphery of the lungs is uniformly clear with an occasional suggestion of septal markings. Density in the thymus area was noted in only a few cases.

WHITE, FRANKLIN W. The modern examination of a patient with chronic indigestion. *J. Am. M. Ass.*, Aug. 23, 1924, lxxxiii, 571–576.

The roentgen-ray examination of the gall-bladder region and after a barium meal is usually made in the study of cases of chronic indigestion. The roentgen-ray examination is essential to accurate diagnosis, and no other single method compares with it for the discovery of gross lesions in the abdomen. The tendency to accept a roentgenological report as final, with inadequate attention to clinical and laboratory aspects is undesirable. The roentgen-ray will discover gross lesions, but it will overlook most of the functional changes which make up the majority of digestive troubles. A patient may have achylia, hyperacidity, chronic gastritis, colitis or even early or nonobstructive cancer of the fundus or posterior wall of the stomach, colon or the mesenteric or retroperitoneal glands, or pancreatic disease or often enough, gallstones, nephritis or anemia.

Whenever there is a conflict between the clinical findings and roentgenological report, the case needs careful study as either method may be wrong. It is advisable to check up the roentgen-ray examination by the test tube or examination of the feces for blood. One should look out for the case with a negative roentgen-ray report and constant blood in the stools.

On the other hand, there is a considerable number of cases in which the diagnosis could not be made without the roentgen-ray, such as diverticula of the esophagus, stomach or bowel, diaphragmatic hernia of the stomach or bowel, hour-glass stomach, foreign bodies, some latent cancers and gallstones, benign tumors and adhesions of the stomach and bowel. It also gives unique information about peristalsis, tone, spasm, and the emptying of the digestive tract and about the condition of postoperative openings. In disease of the gall-bladder most roentgen-ray signs are caused by gross anatomic changes and appear only in the late stages of the disease. The roentgen-ray report is often negative in the milder, earlier cases before adhesions, thickening of the gall-bladder or stones have developed. The new tetrabromphenolphthalein test has shown some remarkable results in the roentgenography of the gall-bladder.

ROENTGEN AND RADIUM THERAPY

BORAK, J. The treatment of climacteric attacks by roentgen irradiation of the hypophysis and thyroid. *München. med. Wchnschr.*, June 27, 1924, lxxi, 864–865.

Roentgen irradiation of the hypophysis primarily and of the thyroid secondarily results in an inhibition of climacteric symptoms which are apparently transmitted by way of the vegetative nervous system. A brief description is given of 3 cases; in 2 of them mere irradiation of the hypophysis was followed in 8 days by a cessation of the acute symptoms. In the third case 4 irradiations of the hypophysis in the course of 5 weeks were unsuccessful, but a treatment of the thyroid resulted in considerable improvement.

It is pointed out that clinically these symptoms occur after cessation of ovarial function and are inhibited after roentgen irradiation of the hypophyseal region or of the thyroid. Irradiation of other portions of the body does not cause their cessation. The action of the roentgen rays is apparently one of impairment in function of the glands irradiated. It would appear that the hypophysis and thyroid are put in a state of hyperfunction during menopause and that this state is responsible for some of the distressing symptoms. The hyperactive glands incidentally offer a more susceptible target to the radiation.

DAVIS, KENNETH S. Intrathoracic changes following *x*-ray treatment: A clinical and experimental study. *Radiology*, October, 1924, iii, 301–322.

Intensive roentgen-ray treatment directed toward the thorax may result, in certain clinical cases, in definite infiltration of the lung, together with pleural involvement, as seen in the roentgenogram. A description is given of 3 such cases. The onset of the affection, when the patient complains of acute symptoms, is apparently due to an acute inflammation; and nearly all of the clinical cases have had what was believed to be pleurisy either with fluid or adhesions. It is impossible to exclude intercurrent infection in certain such cases, and it seems probable that a lowered vitality in the injured tissues would assist such a process. Fibrosis undoubtedly plays a part in the chronic stages but atelectasis cannot be excluded.

An effort was made to study the changes caused in the lung by intensive irradition of experimental animals. Rabbits and dogs were used, and it was found that intensive roentgen treatment can produce pulmonary and pleural lesions in normal animals. The acute type of change was characterized by marked edema and congestion, and the chronic type showed fibrosis and possibly atelectasis. In the experimental animals there was only one instance in which pleurisy was noted. The edema and congestion of the lung are followed by cellular proliferation, especially in the alveolar walls, the majority of the cells being probably connective tissue cells.

These observations would seem to suggest conservatism with regard to the manner in which roentgen radiation is applied in the treatment of carcinoma of the breast and other superficial malignant lesions of the chest wall. A less penetrating type of radiation might perform the necessary work without endangering the chest contents.

LOCKYER, CUTHBERT. The treatment of fibroids of the uterus. *Brit. M. J.*, June 14, 1924, 1037–1040.

Myomectomy during pregnancy is well tolerated by the gravid uterus. It is not indicated for fibroids which lie well up in the abdomen and are causing no symptoms.There is uncertainty in the presence of severe bleeding as to the possibility of saving the gravid uterus; this should act as a deterrent to performing myomectomy unless urgent symptoms call for interference. In wisely selected cases it is believed to be a satisfactory operation.

In 479 abdominal hysterectomies for uterine fibroids the supravaginal operation was performed 284 times with but 5 deaths. There can be no question as to the safety of the operation from the point of view of primary mortality. Such danger as exists concerns the leaving of a potentially malignant cervix. In a series of 195 total hysterectomies for fibroids there were 3 deaths. It seems that the primary risk of both the above operations varies within small limits. Even in women before the age of forty, it is better to conserve one or both ovaries if these organs are healthy.

Experience has shown that the symptomatic treatment of uterine fibroids by radiation is by no means without inherent risk. Quantitative dosage has yet to be attained and there seems to be more hope for the control of radium than for bringing the roentgen rays into quantitative subjection. The mortality risk of radiotherapy of fibroids of the uterus is placed at 1.5 per cent. The risks of actual fatality are by no means negligible so that it becomes a greater responsibility to advise the use of radiotherapy than to advise a radical curative operation. The author is convinced that radium is in every way preferable to roentgen rays for the treatment of uterine fibroids. One application is usually sufficient to check hemorrhage; moreover, it is claimed that radium is less destructive to ovarian tissue than roentgen rays, while the effect on the uterine muscle is greater. Results have been very favorable in the use of radium for the treatment of hemorrhage in chronic metritis. It is regarded as legitimate to consider the use of radium as an alternative to hysterectomy in treating hemorrhage in cases of small uncomplicated uterine fibroids at the time of the climacteric.

In 55 per cent of all fibroids no treatment whatever is needed. Of the remaining 45 per cent, 35 per cent require removal, leaving 10 per cent to be dealt with by radium. This is equivalent to stating that the field for operation is from 3 to 4 times as great as that for radiotherapy.

LÜHRSE, LEO. The therapeutic action of roentgen rays. *München. med. Wchnschr.*, June 20, 1924, lxxi, 836–837.

The author describes a case in which the unintentional administration of a therapeutic dose of roentgen rays produced remarkable recovery from a rapidly progressing arsenic necrosis of the lower jaw. Five or six noncarious teeth had already become loosened and lost in the progress of this necrosis, and it was intended to remove the rest of the teeth in order to combat the process. Before attempting this, it was decided to take a roentgenogram of the jaw. Not knowing the correct exposure time, the operator gave an exposure of 45 minutes with the affected side of the jaw 10 cm. from the roentgen tube. The plate was of course a failure, but the results on the patient were astonishing. Within 2 days the remaining loose teeth in the affected jaw had become more firmly set and the progress of the necrosis had stopped. Examination of the patient 10 years later showed a completely normal appearance of the jaw, except in so far as loss of teeth and substance had altered it.

SCHREINER, BERNARD F., AND KRESS, LOUIS C. Contribution to the treatment of cancer of the lip by irradiation. *J. Cancer Research*, July, 1924, viii, 221–233.

For practical and technical reasons it is necessary to classify the cases of cancer of the lip into three groups. Group 1 includes all lesions confined to the lip up to involvement of the whole lip but with no demonstrable involvement of the lymphatics. The roentgen treatment of this group has resulted, on the average, in 78 per cent of the cases remaining well over a period of 3 years, and 52 per cent remaining well for 5 years.

Group 2 includes lesions of the lip with definite metastases to the lymph channels but still classified surgically as operable. The roentgen treatment in this group has resulted on the average in 39 per cent remaining well over a period of 3 years and 30 per cent remaining well for 5 years.

Group 3 includes the so-called inoperable cases, that is, those far-advanced tumors of the lip with metastases involving the periosteum, with ulceration.

The technique in treating primary lesions is to cover the adjacent skin with lead rubber and to apply 10 ma., 140 kv., without filter at a distance of 20 cm. for a period of 3 to 9 minutes. In Group 1 the lymph-bearing areas in submental or submaxillary regions were not irradiated; but in Group 2 the radiation was applied to the primary lesions as well as to the submental and submaxillary regions. The radiation of the latter was filtered through 3 mm. Al at a distance of 20 to 30 cm.

The above experience is based upon 136 cases, and it has become clear that where there is extensive involvement of the lymphatics, periosteum of the mandible and ulceration it is useless to treat by radiation with expectation of a cure. A review of recent statistics on cancer of the lip shows that the outstanding factor has been the difficulty of obtaining definite conclusions because most investigators have not classified the lesions anatomically, nor have they compared statistics of comparable types of cases treated by surgery as compared with irradiation.

PFAHLER, G. E., AND NASSAU, CHARLES F. A case of malignant degeneration in radiodermatitis, successfully treated by electrocoagulation and skin-grafting. *Radiology*, October, 1924, iii, 297–300.

Following amputation of the left breast in a woman for scirrhous carcinoma, there developed in the axilla and supraclavicular region nodules suggesting metastatic formation. Thorough roentgen-ray treatment was given for this condition and continued for about a year and a half. The patient remained well for nine years, and then returned with a complaint of painful ulcers in the irradiated region, which showed extensive telangiectasis. These local ulcers had the appearance of malignant disease and an attempt was made to destroy them locally by electrocoagulation. This proved insufficient and a year later the entire telangiectatic area was destroyed by electrocoagulation, reaching to the healthy tissue below and the healthy skin at the edges. This treatment resulted, after separation of the dead tissue, in the formation of healthy granulation over the whole area. After treating the area for ten days with Dakin's solution a skin graft was performed. This healed entirely and has remained healthy for the past five years.

BAILEY, HAROLD, AND HEALY, WILLIAM P. Cancer of the uterine cervix, treated by irradiation. *J. Am. M. Ass.*, Oct. 4, 1924, lxxxiii, 1055–1056.

Nearly all of the cases reported on were of the squamous or epidermoid carcinoma type, and the majority of the patients were in an advanced stage of the disease when applying for treatment. From 1918 to 1921, inclusive, the treatment consisted of intensive cross firing of the lesion and the surrounding pelvic structures through the cervical canal, the vagina and the external surface of the body by means of radium alone. In 1921 the external application of radium about the pelvic girdle was supplanted by low voltage roentgen in radiation.

Judging from the experience in the 1024 cases covered by this report, the combination of radium and roentgen-ray therapy is believed to be more effective than radium treatment alone in checking the progress of the disease and in relieving distressing symptoms.

Patients with recurrent cervical cancer were treated when possible by the vaginal bomb applicator, buried bare tubes, and external roentgen radiation. The results indicate that the patients are greatly benefited by this therapy if observed before the lesion is too extensive. Prompt postoperative irradiation after hysterectomy is stated to be an imperative procedure, the neglect of which would seem to be inexcusable.

BÁRSONY, T., AND HOLLÓ, J. The roentgen therapy of dry tuberculous pleuritis. *Ztschr. f. Tuberk., Leipz.*, June, 1924, xl, 278–280.

Roentgen therapy of this disease appeared especially hopeful because of its essentially static and undangerous character, and because of the effective pain alleviation produced by roentgen rays. Roentgen treatment was administered to 16 such chronic cases which had an unquestionable diagnosis and possessed no complicating clinical symptoms. *Technique:* The radiation was applied to the painful area, focal distance, 30 cm., 3 mm. Al filter, the usual dose being ten-thirteenths of an erythema dose. The irradiations were repeated when necessary and possible, at intervals of 3 to 4 weeks. Serious after-effects were not observed. This treatment was unsuccessful in 2 cases. In 6 cases there was practical recovery. The remaining cases were improved to some extent but it was not always possible to repeat the treatments or follow them up.

This treatment was attempted in 2 fresh cases with pleuritic pains one to two days old. A single irradiation sufficed to stop these pains promptly, completely and apparently permanently. It appears, therefore, that roentgen therapy of uncomplicated, chronic dry tuberculous pleuritis (the pleural form of juvenile tuberculosis) relieves in most cases the painful symptoms and renders the patients practically cured. This form of treatment appears to be far preferable to others.

DESJARDINS, ARTHUR U. The reaction of abdominal tumors to radiation. *J. Am. M. Ass.*, July 12, 1924, lxxxiii, 109–113.

The natural history of a given tumor, the degree of differentiation of its cells and of natural resistance offered by the surrounding normal tissues are all factors which must be considered in evaluating effects of roentgen or radium radiation. The tendency of carcinomas to spread by infiltration, to invade the lymph channels and nodes, and the tendency of the invaded normal tissue to counteract these tendencies by attempts to throw up a barrier of lymphocytes or of hyaline or of fibrous tissue must necessarily influence the action of radiation on the malignant cells.

There is no justification for speaking of the selective action of radiation on tissues; any differential action exerted, depends on the cellular sensitiveness of the tissues exposed. Allowing for fairly wide limits of variation, the different types of normal tissue cells may be graded as to sensitiveness to radiation in the following decreasing order: genital glands; seminal epithelium or testes, especially the spermatogonia; germinal epithelium of ovary. Blood; lymphocytes; polymorphonuclear neutrophiles. Spleen and lymphatic glands (lymphocytes). Mucous membranes (intestine, bladder), skin: epithelium. Liver, kidney, muscle, bone, nerve tissue.

The seminoma displays a marked susceptibility to an initial dose of roentgen or radium radiation such as is not possessed by any other abdominal tumor. The normal spleen and lymph nodes are little affected by radiation ordinarily, but when they are in a state of hyperplasia they become markedly susceptible. In chronic leucemia moderate dose of radiation produces a marked effect. With each successive exposure the reaction gradually becomes less pronounced. In Hodgkin's disease the response to radiation is more prompt and more nearly complete when abdominal invasion occurs early; and when late it is more sluggish and never thoroughgoing. In lymphosarcomas, exposure to radiation may be followed by response comparable with that observed in earlier cervical, axillary or mediastinal manifestations of Hodgkin's disease. Certain myomas undergo complete regression and disappear in the course of a few months; in others only partial regression occurs, even after heavy irradiation.

Spindle cell and mixed cell sarcomas are somewhat less radiosensitive than the round cell type; and myxosarcomas, chondrosarcomas, and the osteosarcomas are progressively more resistant in the order named.

FORSDIKE, SIDNEY. Cancer of the cervix. *Brit. M. J.*, July 19, 1924, No. 3316, 94–98.

In the radiation treatment of cancer of the cervix, radium is clinically suitable for 90 per cent of advanced cases. The contraindications are: (a) cases complicated with an old pelvic peritonitis; (b) cachectic cases; (c) fistulae or massively infiltrated vesico-vaginal or recto-vaginal septa and (d) cases with

extensive secondary deposits and nerve root pain. All other cases are worth treating for the remarkable amelioration of symptoms. One of the drawbacks of radium is that it requires several exposures, each one with an anesthetic. Another difficulty is to know when to stop irradiation.

An adjunct to radium treatment is the use of colloidal copper. It has been found that in some way or other it assists in the destruction of the cancerous growth. Maligant ulcers which had contracted and become callous and refractory to irradiation would tolerate further exposures, and the healing process was resumed after the injection of collosol copper.

The policy of irradiating a tumor before operation is limited by the formation of dense fibrous tissue which may render the dissection of the ureters impossible. The advantages of preoperative radiation are that it diminishes the pyogenic infection and cleans up the growth, and secondly, it destroys malignant cells which may remain in unexcised parametrium. Postoperative radiation is a difficult problem for it is not easy to avoid the bladder and rectum after the removal of the uterus. A serious limitation to treatment by radium in early cases is that short of opening the abdomen it is not possible to say whether the glands are involved or not, and if they are the irradiation of the primary growth is merely palliative. The glands are found to be invaded with growth in 30 per cent of the cases that come to operation.

LEWIS, DEAN. Primary giant cell tumors of the vertebrae. *J. Am. M. Ass.*, Oct. 18, 1924, lxxxiii, 1224–1229.

Seventeen cases of primary giant cell sarcoma or tumor of the vertebrae appear in the literature, considering only those cases in which histologic diagnosis has been made. Although local recurrences have been noted, in none of these cases has metastasis occurred.

The author gives abstracts of the histories of 16 cases reported in the literature, and furnishes, in addition, a description of a case observed by him. The latter occurred in a girl aged seven. The roentgen-ray examination revealed definite but not marked change in the body of the fourth dorsal vertebra with a distinct area of rarefaction involving the right half of the body. The outline of the body of this vertebra was broken and somewhat irregular. Although a positive diagnosis of the character of the bone lesion could not be made, it was decided that a transverse lesion of the cord was present secondary to some disease process in the vertebra. At operation a longitudinal incision about 6 inches long was made over the spines of the second, third, fourth and fifth thoracic vertebrae. The laminae were removed and a friable, vascular mass containing calcareous particles was found, extending about 2 inches along the cord and surrounding it. As much of this mass was removed as possible, the dura being left unopened for fear of transplanting the growth within the meninges. Four weeks after the laminectomy the wound was reopened and 50 mg. radium placed in the region formerly occupied by the tumor and was left in position for eighteen hours. Recovery was complete and the child remains practically normal 2 years and 9 months after operation.

The tissue removed was examined histologically and found to resemble that of a giant cell tumor. The history following operation, as well as a diversity of opinion that seems to exist regarding its exact nature suggests that the lesion may represent some chronic resorptive process with excessive formation of granulation tissue, which is not a tumor in the strict sense of the word.

MANNING, WILLIAM J. Expeditious, accurate, roentgen-ray method of determining seventh cervical vertebra. *J. Am. M. Ass.*, July 19, 1924, lxxxiii, 192–193.

The method is applicable to patients of all sizes. With the patient in supine position, the head is raised until the "vertebra prominens" is clearly manifested, and then a length of wire sufficient to project outward on each side for the full width of the body is secured in place with adhesive tape. This special marking of the seventh cervical vertebra has been found convincing before juries in courts of law in injury cases during description of the lesion in the roentgenogram.

MARTINDALE, LOUISA. Treatment of fibromyomas of uterus and other causes of menorrhagia. *J. Am. M. Ass.*, Oct. 4, 1924, lxxxiii, 1057–1060.

In cases in which the size of the tumor did not exceed that of a four or five months' pregnancy, in which the fibroid was interstitial, and menorrhagia the prominent symptom and in which no degeneration of the tumor or complication was suspected, the treatment chosen by the author was that of roentgen irradiation. On the other hand, in cases in which the fibroid or fibroids were definitely pedunculated or submucous or in which the tumor was as large or larger than a six months' pregnancy and especially in cases with a possibility of malignancy, the treatment consisted of operative intervention. Myomectomy is such an ideal operation that it is regarded as the method of choice in young persons.

From 1914 to 1921 the author employed the Freiburg technique using 20 to 22 ports of entry, every 3 weeks and administering 1 or 2 treatments following cessation of menstruation. The dosage was measured by Kienböck strips. In 1922, a modification of the Erlangen technique was introduced. The tube is operated at 150 kv. with 5,200 interruptions in the gas break, 6 to 7 amperes in the primary and a constant 2 ma. through the Coolidge or boiling water tube. In the treatment, each ovary is given 35 per cent of a unit skin dose using an anatomic applicator. Therefore, with 150 kv. and a Coolidge tube at a focal distance of 23 cm., a 32-min. unit skin dose and a 17.5 per cent depth dose, the radiation is administered for 32 minutes anteriorly and posteriorly to each ovary in order to get the 35 per cent dose. This means a treatment of about 2.5 hours. In a woman under thirty years a 40 per cent dose is required. To get this, it is sufficient to apply an extra field at the side of the others or to apply one large field 20 × 15 cm. anteriorly and posteriorly at a longer focal distance. This large field technique is necessary in all cases of fibroid tumor bigger than that of a 4 months' pregnancy.

A good ventilation in the treatment room and proper preparation of the patient beforehand are the best means of preventing roentgen sickness. Another helpful factor is the use of roentgen-ray tubes having the shortest unit skin dose possible. With the Freiburg technique 4 treatments were necessary before menstruation ceased. With the Erlangen technique 1 treatment was ordinarily sufficient to attain this result. Under the operating conditions employed by the author, the small field method at 23 cm. giving 30 to 33 per cent depth dose produces an average amenorrhea from 8 months to a year; with large fields at from 40 to 50 cm. focal distance amenorrhea of 2 years' duration was produced.

In the great majority of cases the tumor diminished under this treatment slowly till at the end of a year it was one-third of its original size and the pressure symptoms were relieved. An apparently beneficial effect of the treatment has been confirmed in a large percentage of the patients examined subsequently.

There is a certain danger in using intensive roentgen therapy for any but cases of fibroid uterus well under the size of a 6 months' pregnancy, interstitial rather than subperitoneal, and in which the chief and only symptom is extensive menorrhagia. Early operation for carcinoma of the fundus uteri has such a good prognosis that one cannot be too careful to eliminate the possibility of its existence before undertaking roentgen therapy. The roentgen-ray dose sufficient for climacteric hemorrhage or fibromyoma is only approximately one quarter of the dose necessary for carcinoma so that an error in diagnosis in such a case may be dangerous. Carcinoma of the cervix is less likely to be missed except in those cases in which the origin is in the cervical canal.

Pomeroy, Lawrence A., and Strauss, Abraham. Carcinoma of cervix uteri. *J. Am. M. Ass.*, Oct. 4, 1924, lxxxiii, 1060–1062.

This report is based on 100 consecutive cases of carcinoma of the cervix in patients applying for radium treatment. The special purpose of the study of this series of cases was to find out whether the microscopic examination could enable an accurate prognosis. The exact radium dosage varied in the individual cases but as a rule the treatment consisted of 100 mg. radium element screened with 0.5 mm. silver, 1 mm. brass and 1.5 mm. rubber, in the cervical canal and from 5 to 10 steel needles containing 5 to 12.5 mg. radium element inserted directly into the tissues of the cervix. The total dose was about 3000 mg-hr., which was not repeated for two or three months, if at all.

The cell types found were classed according to the Martzloff classification, i.e., polyhedral spinal type, round transitional type, and long, fat spindle type. In theory, at least, the least malignant cells (the spinal type) are the least radiosensitive, and the most malignant cells are the most radiosensitive. In the group of primary cases with involvement of vaginal wall and broad ligaments the results were classified according to the cases apparently arrested (symptomatically and on examination) after 6, 12, 18 and 24 months. The best results were obtained in the spinal cell type with pearls, and in the adenocarcinomas. It was rather surprising to find a large proportion of palliations (71 per cent) obtained in the transitional type for the first six months' period. This percentage, of course, decreased rapidly in the later periods. This suggests that the cells of this group may be quite sensitive to radium and brings up the question of the advisability of repeating irradiations in even apparently quiescent cases of this group.

Richardson, E. P., and Means, J. H. Results of surgery and of surgery combined with roentgen-ray treatment in exophthalmic goiter. *Arch. Surg.*, September, 1924, ix, 237–255.

There is no reason to believe that roentgen-ray treatment for a few months in early selected cases increases the operative risk. Certain

patients who show a drop in metabolism and pulse rate and an increase of weight during roentgen-ray treatment are distinctly better risks than they were at the time the treatment was begun. It cannot be shown, however, that cases which prove resistant to roengten-ray treatment require fewer preliminary operations or have a lower operative mortality than the cases treated entirely by surgery. A considerable proportion of the patients treated by radiation do not undergo surgery, and to this extent the immediate total operative risk is reduced.

In regard to the technical difficulty of the operation itself, it is the opinion of Richardson that cases treated with roentgen radiation show no noteworthy increase in operative difficulty.

The data presented in this paper have no bearing on the general effectiveness of roentgen-ray treatment or on its value as a preoperative measure in reducing operative risk. With regard to roentgen-ray treatment, conclusions may be drawn from the evidence here presented only as to the extent that previous roentgen-ray treatment influences surgery, and in lesser degree as to the extent that previous operation influences roentgen-ray treatment.

In 7 cases ligation of the superior thyroid arteries appeared to be more effective following treatment with roentgen radiation but this variation may well be due to the small number of cases. In one additional case the patient was apparently cured by these measures. Six cases are reported which show no evidence that the effectiveness of roentgen-ray treatment is increased by ligation of the superior thyroid arteries. In comparing 13 cases of hemithyroidectomy without roentgen-ray treatment with 10 such cases receiving roentgen-ray treatment, it is concluded that the amount of benefit received by surgical treatment is not increased by previous roentgen-ray treatment.

The results of subtotal thyroidectomy are very similar in the cases receiving roentgen-ray treatment and those not receiving it. There is no evidence that cases in which roentgen-ray treatment was given show an increased tendency to myxedema after subtotal thyroidectomy. It is concluded that the effect produced by surgery in the treatment of exophthalmic goiter appears little modified by previous roentgen-ray treatment.

Rulison, R. H. The prophylaxis of roentgen-ray overdosage. *J. Am. M. Ass.*, Nov. 8, 1924, lxxxiii, 1505–1506.

Through the omission of the aluminum filter, a woman sixty-three years old was given an unfiltered dose of roentgen radiation ($4\frac{1}{3}$ skin units) sufficient to cause a severe burn. The radiation was applied to a skin lesion that suggested malignant degeneration. The mistake in dosage was detected before the patient left the office, and a series of increasing doses of ultraviolet light was applied from a Kromayer lamp. To avoid confusion of the expected erythemas, a larger area was treated with ultraviolet light than had been exposed to the roentgen rays. Only a moderate erythema was caused by the light.

No roentgen-ray reaction appeared until the twelfth day and was then only slight. This erythema persisted for ten days and was followed by the faintest desquamation. Ninety days after the roentgen-ray overdose the skin appears perfectly normal.

Soiland, Albert. Comments on the use of radium for intra-oral cancer. *J. Am. M. Ass.*, Aug. 9, 1924, lxxxiii, 410–412.

Among the hopeful cancerous involvements of the intra-oral structures are those neoplasms which originate in the gum or soft alveolar tissues and which are accessibly located. Radium is still the one outstanding agent in the treatment of these conditions. Four typical cases are briefly outlined.

Watkins, W. W. Pathologic basis for roentgen-ray treatment of tonsil disease. *J. Am. M. Ass.*, Oct. 25, 1924, lxxxiii, 1305–1308.

The tonsil is an important organ and should be conserved when possible through the adolescent period. The following types of pathologic change in the tonsil are amenable to irradiation and should be so treated by preference.

Simple hypertrophy yields to radiation treatment by shrinkage to a normal or atrophic condition so readily and gradually that there is no danger or discomfort to the patients. Chronic interstitial tonsillitis of the hyperplastic type can be made to subside under irradiation quickly and effectively so that, barring emergencies, there is no comparison between radiation and tonsillectomy. The crowding mass of lymphoid cells is quickly dispersed, the size of the tonsil rapidly shrinks, the crypts open up and become shallower and the infection subsides.

In the chronic fibrous interstitial tonsillitis and in chronic follicular tonsillitis with little or no hyperplasia the conditions are not so remediable by radiation, and the results will depend entirely on how much lymphoid tissue there is present and how effectively the crypts can be obliterated by shrinkage. It is believed that, as a rule, such tonsils if dangerous to

the general health had better be removed. When there is evidence of retained pus within the tonsil or internal to it, tonsillectomy is the preferable treatment. Unless some other type of treatment is called for by the clinical condition, a hypertrophy or hyperplastic pathologic type in the absence of suppuration can best be handled by irradiation.

WOOLSTON, W. J., AND CRAIN, R. C. A protective method of applying radium in the cervix. *J. Am. M. Ass.*, Nov. 1, 1924, lxxxiii, 1429.

Dental impression compound is molded into the form of a hollow cone and made to fit snugly over the cervix so that the margins of the cone completely fill the fornices of the vagina. This mold acts not only as a screen but also as a mechanical barrier pushing away the vaginal walls. A hole is made in the apex of the cone through which the braided silk is drawn, the proximal end being attached to the radium container and the distal end strapped over the pubis. The vagina is then packed with gauze and a pad and binder are applied. It is claimed that this molding compound is of sufficient density to absorb radiation and thus protect adjacent tissues.

MISCELLANEOUS

HILL, EBEN C. Notes on an opaque x-ray mass. *Johns Hopkins Hosp. Bull.*, July, 1924, xxxv, 218–221.

This is a preliminary report on an opaque injection mass which is readily prepared and gives clear, sharp outlines of the arteries and arterioles and may be made so as not to pass into the capillaries.

The injection mass is made up of 15 to 18 gm. of bismuth oxychloride (prepared for roentgen-ray work), 5 to 10 gm. of acacia, and water sufficient to bring the volume up to 100 c.c. The acacia is well pulverized and slowly added to boiling water. It is preferable to use distilled water for this purpose. The bismuth oxychloride is added slowly to a portion of this hot acacia solution and rubbed to a thin paste. This paste is then slowly stirred into the entire solution. The mass is then filtered through layers of closely woven linen cloth, and the filtrate tested by hypodermic needle or with a drop of blood to determine the approximate size of the particles contained. When the size of the bismuth particles is from 10 to 35 microns the mixture is suitable for injection and will fill the arterioles but will not enter the capillaries. Filtration yielding particles of 4 to 7 microns in diameter produces a mass which will easily spread into the capillary structures and may be injected from a No. 27 G. needle.

It is advisable to make the injections of tissues, animals or embryos before rigor mortis or blood clotting has begun. The solution in the concentration given is for post mortem injections only and cannot be used on living animals without dilution. In making roentgen plates, medium soft rays from a fine point focus and with increased time are necessary to bring the smallest vessels into clear outline.

JOANNIDES, MINAS, AND RILEY, WILLIAM A. Echinococcus cyst in the scapular area. *Arch. Surg.*, November, 1924, ix, 537–544.

A case is reported because of the uncommon location of the cyst, and because it gives strong evidence that the infection may be carried through the general circulation to various parts of the body. The condition was observed in a Greek housewife, aged 45, complaining of a painful lump over the left scapula. Abscess was suspected and on being opened, thick yellow pus under pressure appeared. When the capsule was incised a number of grape-like cysts appeared. These varied from a few millimeters to over 2 cm. in diameter. Microscopic examination of the cysts fixed the diagnosis of echinococcus. The incision was enlarged and the cyst removed, care being taken to remove also the fibrous wall of the cyst. This treatment resulted in a cure and no recurrence was noted six months after operation.

JUDD, E. S., SCHOLL, ALBERT J., KEYSER, L. D., AND GOULDS, G. S. A review of urologic surgery. *Arch. Surg.*, November, 1924, ix, 653–688.

It is not possible to give an adequate abstract of this extensive review. Under the heading "kidney" the following divisions are considered: surgical technique, tumors of the kidney, nephrolithiasis, renal tuberculosis, actinomycosis, anomalies, cysts. Under the heading "ureter" the subject of carcinoma is considered. Under the heading "bladder" there are considered diverticulum and tumors. The other subjects considered are prostate, urethra, testes and seminal vesicles, exstrophy of the bladder, anesthesia in urology and urinary infection. Fifty-eight references are quoted.

MAYOR, JAMES W., AND DE FOREST, DAVID M. The relative susceptibility to *x*-rays of the eggs and sperm of *Arbacia*. *Proc. Soc. Exper. Biol. & Med.*, October, 1924, xxii, 19–21.

The roentgen radiation was applied to sea urchin eggs and sperm at 19° to 22°C. with a

standard Coolidge tube, tungsten target at 50 kv., 3 ma., 25 cm. cell-target distance. Eggs were irradiated and then fertilized with normal sperm in one set of experiments, and in the other, irradiated sperm were used to fertilize normal eggs. Fertilizations with normal eggs and sperm were used as controls. The rate and type of development of the resulting larvae were the criteria of the effect of the roentgen treatment.

It was found that the variation in the degree of development at the time of examination was greater in larvae developed from irradiated germ cells as compared with the controls, and greatest in those developed from eggs fertilized by irradiated sperm. Dosage was calculated from the formula: $D = \frac{\text{ma-min.}}{(\text{target distance})^2}$. It was observed that all doses used, even the smallest (3 ma., 5 min., 25 cm.) caused a retardation in development, that the amount of retardation increased with the dose; and that for the same treatment, the amount of retardation was always greater when the sperm were irradiated than when the eggs were irradiated.

MUTSCHELLER, A. Average wave lengths of *x*-rays. *Radiology*, October, 1924, iii, 328–334.

From the use of the so-called standard sphere gap and standard well-damped milliampere meters conclusions are ordinarily drawn as to the quality and quantity of the roentgen rays produced. It appears, however, that great irregularities occur in the results when attempts are made to duplicate conditions. This shows that the present measuring methods are not sufficiently well defined for estimating, comparing and repeating doses. In order to transform effective voltages into peak volts the root-mean-square voltages are multiplied by $\sqrt{2}$, or 1.41; but this factor is correct only when the voltage wave is exactly a complete sinusoidal curve. On the other hand, the voltage delivered by a modern transformer and mechanical rectifier measured with a sphere gap does not have the sinusoidal wave form because usually the beginning and end parts of the sine wave impulse are intentionaly cut off. If, for instance, 30° are cut off at the beginning and end of the impulse then the peak voltage is 1.82 times the effective voltage. A table of conversion factors is calculated for various rectifier segment lengths. This table shows that if the rectifier arcs subtend angles of less than 90° then the voltages measured with the sphere gap would be considerably higher than for the pure sine curve.

This observation was tested experimentally and the differences found were in fair agreement with those calculated. No absolute information whatsoever can be derived from the milliampere meter readings either with regard to the quality of the rays generated or the composition of the roentgen-ray beam. A fair idea of the composition of the roentgen-ray beam is obtained if the radiation is passed through filters and the transmitted radiation intensities are measured. If the radiation is quite nearly homogenized then there is less absorption in a given filter thickness than if the beam contains a large percentage of less penetrating rays.

Errors in the adjustment of the rectifier are not easily recognized by visual inspection but they become quite clear in the oscillograph if a homogenizing filter of copper is used. That is, the milliampere meter may indicate the total current used in operating the tube, but it does not give an indication of the intensity of the useful penetrating radiation; hence it cannot be depended on for absolute dosage but only for the repetition of already standardized doses or the control of roentgen-ray generating current.

Determination of the average wave length of radiation, defined as the wave length of an equivalent homogeneous radiation whose absorption is equal to that of the radiation tested, is considered a better and more easily reproducible criterion from the standpoint of dosage. Because of the ease and accuracy with which the average wave length, the correct filter thickness, and the transmitted useful portion of radiation can be determined, and because of their much better definition and usefulness in deep roentgen therapy, it is proposed by the author that they be used in the clinical roentgen therapy laboratory.

HORDER, SIR THOMAS. The influence of radiology upon our conceptions of disease. *Brit. M. J.*, July 19, 1924, No. 3316, 89–94.

This is a general lecture in which is pointed out the influence of roentgenology upon the conceptions of disease from the standpoint of diagnosis and therapy. The visualization of certain processes permitted by roentgenoscopy comprises one phase of this altered conception. The treatment of disease conditions by radiant energy comprises the other aspect. The roentgenographer is under the disadvantage of dealing not with substances but with shadows, and the plea is made for objective interpretations and against diagnoses made in the absence of other clinical data equally important.